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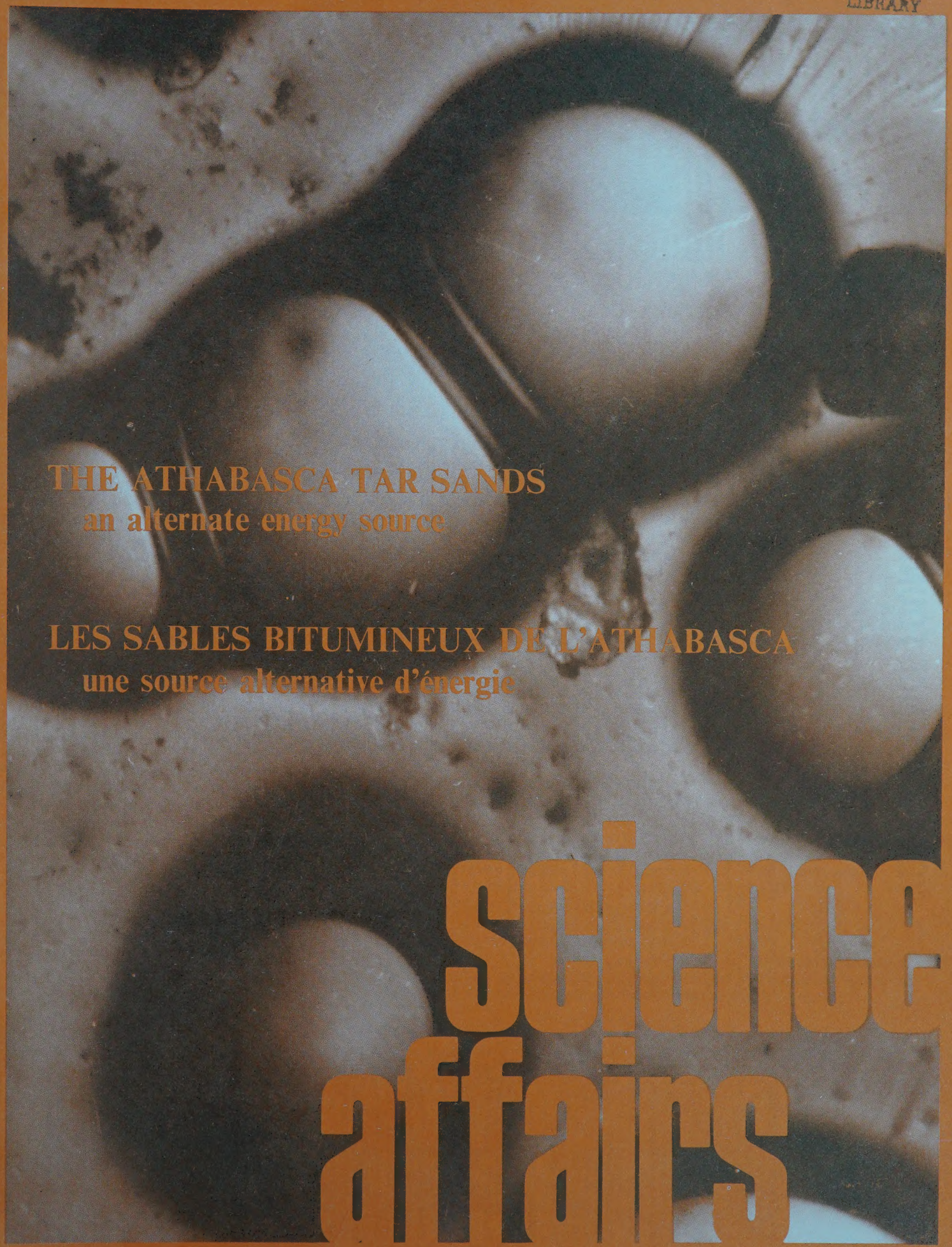

# THE ATHABASCA TAR SANDS
## an alternate energy source

# LES SABLES BITUMINEUX DE L'ATHABASCA
## une source alternative d'énergie

# science affairs

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**RESPECT POUR L'ENVIRONNEMENT** 27
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COVER PHOTO

Not craters on the moon – but an extreme close-up of air bubbles surrounded by bitumen, during the process of extracting bitumen from tar sand using the "hot water separation process".

PHOTO SUR COVERTURE

Ce ne sont pas des cratères sur la lune – mais un gros plan de bulles d'air entourées de bitume, pendant le procédé d'extraction du bitume des sables bitumineux utilisant "le procédé de séparation à l'eau chaude".

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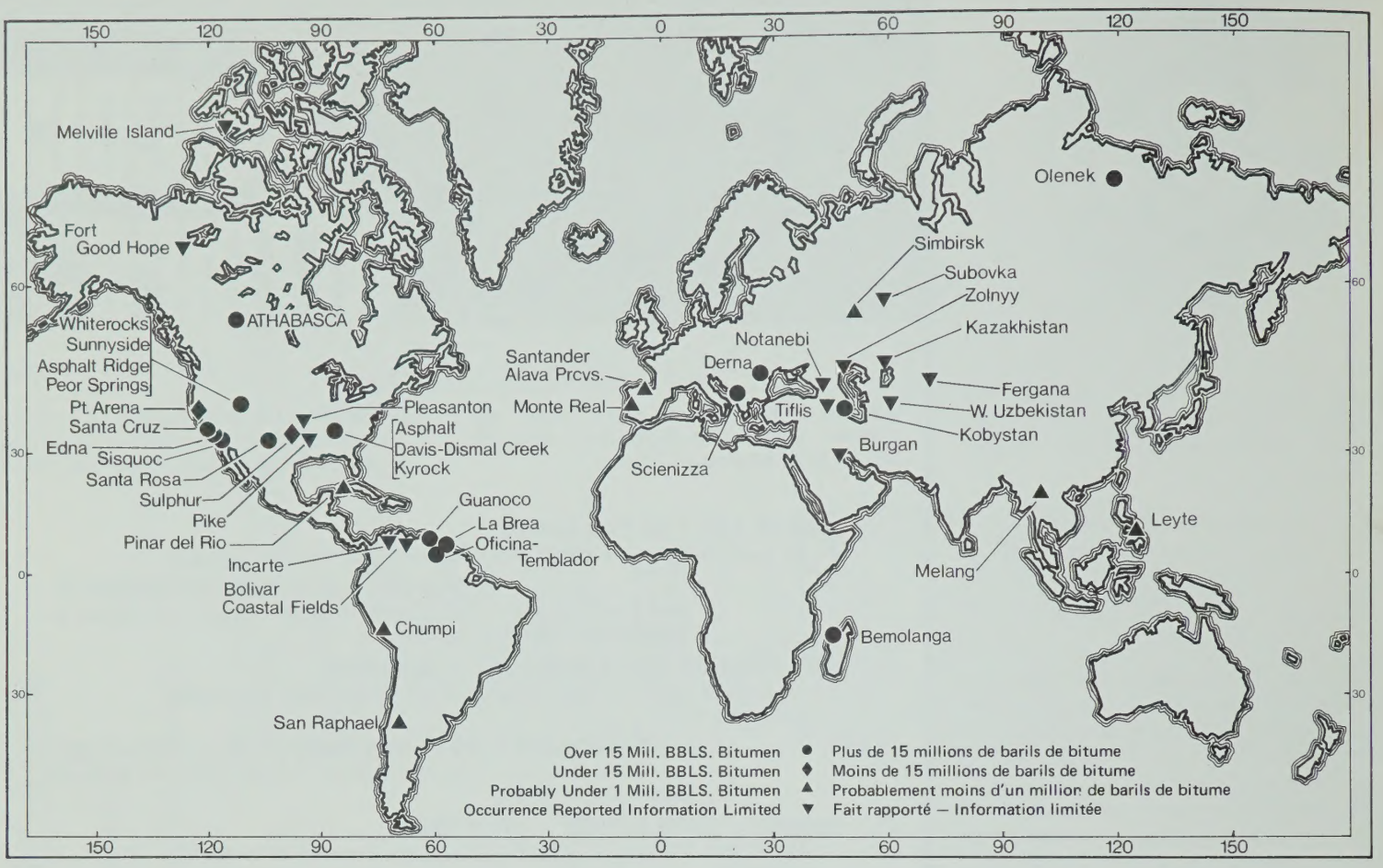



# WHERE ARE THE TAR SANDS?

*by Lois Bridges*

Although Canada can lay claim to the world's largest single tar sands deposit, major deposits also occur in South America, Africa, U.S.A., Europe and U.S.S.R.

Major deposits are considered those with reserves of more than 15 million barrels of synthetic crude oil. In addition, there are several deposits in various parts of the world which contain smaller reserves. Location of both major and minor deposits is shown on the map (fig. 1).

The Athabasca Tar Sands make up the major deposits of reserves of heavy oil which stretch from the Alberta-Saskatchewan border in the east to a point near the town of Peace River in the north-central section of the province. This one deposit accounts for over 600 billion barrels of bitumen in place which could ultimately yield close to 300 billion barrels of synthetic crude oil.

The other deposits are Cold Lake (164 billion barrels of bitumen in place), Wabasca (54 billion barrels) and Peace River (51 billion barrels). These differ from the Athabasca sands which surround the town of Fort McMurray in that they contain deposits of heavy oil which are too deep to recover by existing mining methods.

By comparison, the tar sands of eastern Venezuela, which stretch for 375 miles along the northern banks of the Orinoco River, are estimated to contain bitumen reserves of 200 billion barrels. In Africa, tar sands located near Bemolanga on the island of Malagasy have reserves of 2 billion barrels. These two deposits are generally considered second and third in significance to the Alberta deposits.

The recent discovery of widely separated outcrops of oil-soaked sands on Melville Island in the Northwest Territories, may change this picture. Since 1962, when Calgary geologist G.V. Lloyd identified the deposit, there has been speculation that it may eventually take second place to the Athabasca sands in terms of size. However, severe weather conditions and problems with permafrost have made it difficult for geologists to establish the exact size of the deposit which is located at Marie Bay on the northwest tip of the island.

The United States has a number of significant tar sands deposits, most of which are located in Utah, California New Mexico and Kentucky.

In Europe, the sands are found in Albania, Rumania and the U.S.S.R.

## ATHABASCA SANDS

To date, the Athabasca sands have received most attention from scientists and commercial developers, mainly because the area is large, easily accessible and has deposits lying close enough to the surface to allow open pit mining. Existence of the oil-bearing sands is particularly obvious along the Athabasca River where the sticky, black mixture of sand

# OU SONT LES SABLES BITUMINEUX?

*par Lois Bridges*

Bien que le Canada peut prétendre avoir le gisement de sables bitumineux le plus grand au monde, l'Amérique du Sud, l'Afrique, les Etats-Unis, l'Europe et l'URSS ont aussi des gisements importants.

On considère comme gisements importants ceux qui ont des réserves de plus de 15 millions de barils de pétrole brut synthétique. De plus, il existe plusieurs gisements dans différentes régions du globe qui contiennent de plus petites réserves. L'emplacement des gisements importants et secondaires est indiqué sur la carte (fig. 1).

Les gisements les plus importants de réserves de pétrole lourd sont les sables bitumineux de l'Athabasca qui s'étendent à partir de la frontière de l'Alberta et du Saskatchewan à l'est, jusqu'à un point près de la ville de Peace River, située au nord de la province. Ce gisement, à lui seul, représente 600 milliards de barils de bitume qui pourrait éventuellement produire près de 300 milliards de barils de pétrole brut synthétique.

D'autres gisements sont à Cold Lake (164 milliards de barils de bitume), Wabasca (54 milliards de barils) et Peace River (51 milliards de barils). Ceux-ci diffèrent des sables de l'Athabasca qui enserrent la ville de Ft. McMurray, parce qu'ils contiennent des gisements de pétrole lourd trop profond pour réussir à le récupérer selon les méthodes minières existantes.

En comparaison, les sables bitumineux de l'est du Venezuela, qui s'étendent sur 375 milles le long des berges-nords de la rivière Orinoco, contiennent approximativement des réserves de 200 milliards de barils de bitume. En Afrique, des sables bitumineux localisés près de Bemolanga sur l'île de Madagascar ont des réserves de 2 milliards de barils. Ces deux gisements sont généralement considérés deuxième et troisième en comparaison aux gisements de l'Alberta.

Il se peut que la découverte récente d'affleurements de sables saturés de pétrole, isolés les uns des autres, sur l'île Melville dans les Territoires du Nord-Ouest, occasionnera des changements. Depuis 1962, lorsque le géologiste G.V. Lloyd de Calgary a identifié le gisement,

## TAR SAND DEPOSITS IN ALBERTA

## GISEMENTS DE SABLES BITUMINEUX EN ALBERTA

clay, water and crude bitumen can be seen along the banks for a distance of 100 miles north and south of the town of Fort McMurray.

Because of this unique feature of the Athabasca Tar Sands, it is one of the few deposits in the world to have attracted commercial development. Some development has also taken place in the tar sands of Trinidad, Albania, Rumania and the U.S.S.R. In addition, the U.S., Venezuelan and African deposits have all attracted the interest of major oil companies at one time or another.

On the basis of information presently available, experts say major accumulations of tar sands in the world contain reserves of well over 1,000 billion barrels of bitumen.

It must be remembered, however, that because so much of the oil is trapped beneath hundreds of feet of overburden, by no means all of this resource can be tapped, using present technology. Once overburden reaches a depth of 200 feet, it's no longer considered economical to mine the sands and researchers are only now beginning to perfect processes for recovering the oil by separating it from the sand while in place, then pumping it to the surface.

Until recently, most of us heard very little about the tar sands. This may seem odd in view of the fact that world preoccupation with conventional oil exploration, discoveries and reserves has kept these subjects constantly in the news for years. Why the sudden flurry of excitement over a resource that, like conventional oil, has existed for millions of years?

The answer is that, for a long time, conventional crude oil has been a relatively inexpensive and easily accessible source of energy. Until scientists began to warn the world that supplies of conventional oil would soon start diminishing, it was simply considered too unwieldy and expensive to develop the tar sands. Now, alternative energy sources such as the tar sands, coal, oil shales and nuclear power are receiving increased attention. With commercial production from tar sands already under way, it seems likely the potential of this energy source will be among the first to be exploited.

Although 'tar sands' is the name most commonly given to the sands containing the thick, black tar-like crude hydrocarbon material known as bitumen, they're also referred to as 'oil sands', 'bituminous sands', or 'asphalt sands'. Whatever the terminology used, it's been noted that properties of the bitumen from which the synthetic crude oil is produced, appear to differ very little from one geographic location to another, at least in the various Alberta deposits. However, the thickness of deposits and their quality (the extent to which the sand grains are saturated with oil) vary widely from location to location. This is true of tar sands deposits generally.

**MAJOR TAR SANDS OF THE WORLD**

| Country | Name of Deposit | Areal Extent (acres) | Areal Extent (sq. miles) | Overburden Thickness (ft.) | In Place Reserves (million bbls) |
|---|---|---|---|---|---|
| Canada | McMurray-Wabiskaw, Alberta | 5,750,000 | 9,000 | 0-1,900 | 625,900 |
| | Cold Lake, Alberta | 1,200,000 | 1,875 | 700-2,600 | 51,500 |
| | Peace River, Alberta | 1,100,000 | 1,625 | 300-1,400 | 33,400 |
| | TOTAL "Alberta Oil Sands" | 8,000,000 | 12,500 | 0-2,600 | 710,800 |
| | Melville Island, N.W.T. | unknown | unknown | 0-2,000 | unknown |
| Eastern Venezuela | Oficina-Tremblador Tar Belt | 5,750,000 | 9,000 | 0-3,000 | 200,000 |
| Malagasy | Bemolanga | 96,000 | 150 | 0- 100 | 1,750 |
| U.S.A. | Asphalt Ridge, Utah | 11,000 | -- | 0-2,000 | 900 |
| | Sunnyside, Utah | 34,300 | -- | 0- 150 | 500 |
| | Whiterocks, Utah | 1,900 | 3 | nil | 250 |
| | Edna, California | 6,595 | 10 | 0- 600 | 165 |
| | Peor Springs, Utah | 1,735 | <3 | shallow | 87 |
| | Santa Rosa, New Mexico | 4,630+ | 7 | 0- 40 | 57 |
| | Sisquoc, California | 175 | -- | 15- 70 | 50 |
| | Asphalt, Kentucky | 7,000 | 11 | 6- 30 | 48 |
| Albania | Selenizza | 5,306 | 8 | shallow | 371 |
| Trinidad | La Brea | 126 | -- | nil | 60 |
| Rumania | Derna | 459 | -- | shallow | 25 |
| U.S.S.R. | Cheildag, Kobystan | 82 | -- | shallow | 24 |

**SABLES BITUMINEUX LES PLUS IMPORTANTS AU MONDE**

| Pays | Nom du gisement | Etendue de la région (acres) | Etendue de la région (milles carrés) | Epaisseur de la surcharge (pieds) | Réserves en place (millions de barils) |
|---|---|---|---|---|---|
| Canada | McMurray-Wabiskaw, Alberta | 5,750,000 | 9,000 | 0-1,900 | 625,900 |
| | Cold Lake, Alberta | 1,200,000 | 1,875 | 700-2,600 | 51,500 |
| | Peace River, Alberta | 1,100,000 | 1,625 | 300-1,400 | 33,400 |
| | TOTAL "Sables Huileux de l'Alberta" | 8,000,000 | 12,500 | 0-2,600 | 710,800 |
| | Ile Melville, N.W.T. | inconnu | inconnu | 0-2,000 | inconnu |
| Venezuela-Est | Ceinture Bitumineuse Oficina-Tremblador | 5,750,000 | 9,000 | 0-3,000 | 200,000 |
| Madagascar | Bemolanga | 96,000 | 150 | 0- 100 | 1,750 |
| Etats-Unis | Asphalt Ridge, Utah | 11,000 | -- | 0-2,000 | 900 |
| | Sunnyside, Utah | 34,300 | -- | 0- 150 | 500 |
| | Whiterocks, Utah | 1,900 | 3 | rien | 250 |
| | Edna, California | 6,595 | 10 | 0- 600 | 165 |
| | Peor Springs, Utah | 1,735 | <3 | peu profonde | 87 |
| | Santa Rosa, Nouveau-Mexique | 4,630+ | 7 | 0- 40 | 57 |
| | Sisquoc, Californie | 175 | -- | 15- 70 | 50 |
| | Asphalt, Kentucky | 7,000 | 11 | 6- 30 | 48 |
| Albanie | Selenizza | 5,306 | 8 | peu profonde | 371 |
| Trinidad | La Brea | 126 | -- | rien | 60 |
| Roumanie | Derna | 459 | -- | peu profonde | 25 |
| U.R.S.S. | Cheildag, Kobystan | 82 | -- | peu profonde | 24 |

## ECONOMIC POTENTIAL

To understand the economic potential of the various deposits, it's necessary to consider the size of the deposits, the depth of their formations (or pay thickness), the degree to which the sands are saturated with bitumen--and their accessibility. Not only is it important to consider the depth of the sands, but also their location in terms of transportation facilities and markets. All of these factors will help to decide when and how full-scale development of the tar sands takes place.

Because tar sands research is relatively new, much of the information shown in the accompanying chart (fig. 4) is based on estimates. However, it serves to give some idea of the relative commercial importance of the various deposits.

For example, it's easy to understand why the Athabasca sands would be considered a good bet for commercial development. Not only are they largest in terms of square miles, but the deposits are relatively thick and of good quality,

il y a eu des hypothèses qu'il se peut qu'éventuellement il prenne la deuxième place par ordre de dimensions, après les sables de l'Athabasca.

Cependant, les géologistes on eu de la difficulté en raison des intempéries et des problèmes de permafrost qui on rendu difficile la tâche d'établir la dimension exacte du gisement qui se trouve à Marie Bay à l'extrémité nord-ouest de l'île.

Les Etats-Unis on bon nombre de gisements importants de sables bitumineux, dont la plupart sont situés au Utah, en Californie, au Nouveau-Mexique et au Kentucky. En Europe, on trouve les sables en Albanie, en Roumanie et en URSS.

## LES SABLES DE L'ATHABASCA

Jusqu'à date, la majeure partie de l'intérêt porté aux sables de l'Athabasca provenait plutôt de scientifiques et entrepreneurs commerciaux, surtout parce que la région est vaste, facile d'accès et a des gisements assez près de la surface pour permettre de miner à fosse ouverte. L'existence des sables oléagineux est particulièrement évidente le long de la rivière Athabasca où on peut voir la substance gluante noire d'un mélange de sable, d'argile, d'eau et de bitume brut le long des berges sur une distance de 100 milles au nord et au sud de la ville de Ft. McMurray.

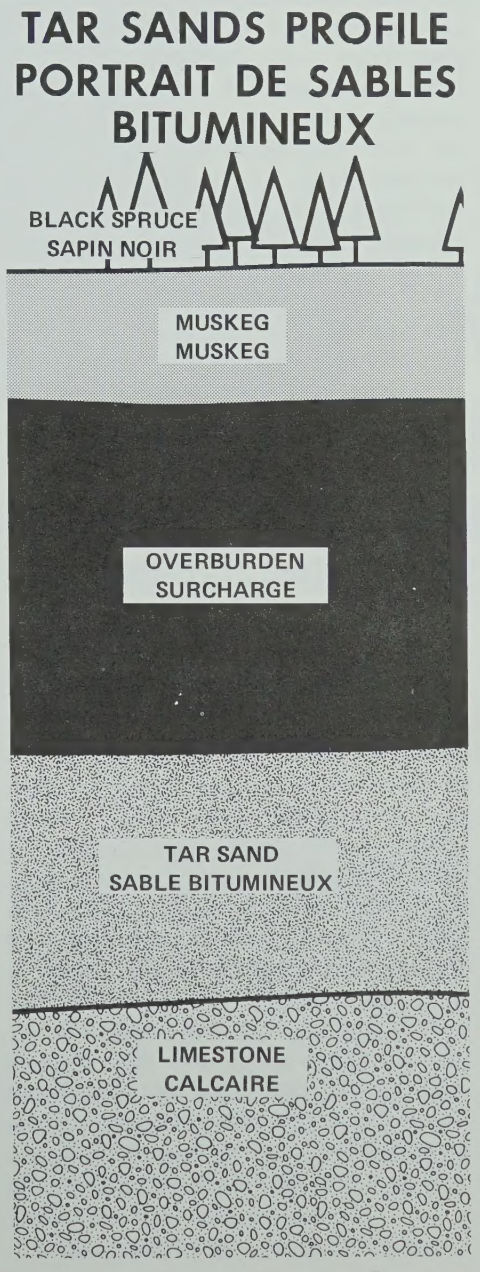
A cause de cette unique caractéristique des sables bitumineux de l'Athabasca, c'est un des rares gisements au monde qui a attiré un développement commercial. Les sables bitumineux de Trinidad, de l'Albanie, de la Roumanie et de l'URSS ont aussi été l'objet d'un certain développement. De plus, les gisements des Etats-Unis, du Venezuela et de l'Afrique ont tous reçu l'intérêt de compagnies pétrolières importantes de temps à autre.

Se basant sur les informations disponibles présentement, les experts disent que les accumulations de sables bitumineux importantes au monde contiennent des réserves de plus de 1,000 milliards de barils de bitume.

On doit se rappeller, cependant, que parce que tellement de pétrole est bloqué sous plusieurs centaines de pieds de surcharge, en aucune manière peut-on s'attendre à 'percer' cette ressource en utilisant la technologie actuelle. Lorsque la surcharge mesure 200 pieds, on ne condidère plus cela économique de miner les sables et les chercheurs commencent seulement à perfectionner les procédés de récupération du pétrole en le séparant du sable lorsqu'en place, ensuite en le pompant à la surface.

La plupart parmi nous entendaient très peu parler des sables bitumineux jusqu'à récemment. Ceci peut sembler étrange en vue de la préoccupation du monde envers l'exploration conventionnelle du pétrole, des découvertes et réserves, ces sujets défrayent constamment la chronique de puis des années. Pourquoi cette soudaine fièvre d'agitation envers une ressource qui, tel le pétrole conventionnel, existe depuis des millions d'années?

La réponse est que, depuis longtemps, le pétrole brut conventionnel est une source énergétique peu coûteuse et facile d'accès. Avant que les scientifiques commencent à prévenir le monde que les approvisionnements de pétrole conventionnel diminueraient bientôt, on considérait les sables bitumineux trop coûteux et peut maniables à développer. Maintenant, l'intérêt augmente envers les sources alternatives énergétiques, tel que les sables bitumineux, le charbon, les schistes huileux et le pouvoir nucléaire. Il semble possible qu'avec la production commerciale des sables bitumineux déjà entreprise, le potentiel de cette source énergétique sera parmi un des premiers à être exploité. Bien que 'sables bitumineux' soit le nom communément donné aux sables contenant le matériel brut d'hydrocarbure épais, noir tel du goudron, appellé bitume, on les appelle aussi 'sables oléagineux', et 'sables-asphalte', Peu importe le terme utilisé, on a remarqué que les propriétés du bitume dont le pétrole synthétique est produit, semble différer très peu d'une région géographique à une autre, du moins dans les divers gisements de l'Alberta. Cependant, l'épaisseur des gisements et leur qualité (le degré auquel les grains de sable sont saturés de pétrole) varient grandement d'une région à l'autre. Ceci est vrai des gisements de sables bitumineux en général.




## POTENTIEL ECONOMIQUE

Pour comprendre le potentiel économique des différents gisements, il est nécessaire de considérer la dimension des gisements, l'épaisseur des plis (ou épaisseur-payante), le degré auquel les sables sont saturés de bitume – et leur facilité d'accès. Non seulement est-ce important de considérer la profondeur des sables mais aussi leur emplacement en termes des facilités de transport et des débouchés économiques. Tous ces facteurs aideront à décider où et comment un développement de grande envergure des sables bitumineux aura lieu.

Parce que la recherche concernant les sables bitumineux est relativement nouvelle, la plupart des détails donnés dans le tableau ci- joint (fig. 3) sont approximatifs. Cependant, ils servent à donner un aperçu de l'importance relative commerciale des divers gisements.

Par exemple, on comprend facilement pourquoi les sables bitumineux de l'Athabasca sont considérés comme un bon pari lorsqu'il s'agit de développement commercial. Non seulement sont-ils les plus grands en termes de milles carrés, mais les gisements sont relativement épais et de bonne qualité, ayant un point de saturation de bitume brut à partir de 0 à 18% et, en moyenne, de 12%.

Au Venezuela, le gisement le long de la

with crude bitumen saturation ranging from zero to 18 per cent and averaging 12 per cent.

In Venezuela, the deposit along the Orinoco River is almost the same size as the largest of the Alberta deposits, but overburden is estimated to be as thick as 3,000 feet in some areas, which could make recovery of its estimated 200 billion barrels of crude bitumen extremely difficult.

In contrast, deposits in Africa's Malagasy in the Indian Ocean are much smaller than either the Venezuelan or Canadian deposits. Although they cover only 150 square miles, the bitumen appears relatively easy to recover since overburden thickness varies from zero to 100 feet and could be reached by a surface mining operation.

The Melville Island deposit, located some 1,450 miles north of Edmonton, is interesting because of the unique climatic conditions that exist there. Although overburden depth is roughly the same as in the Athabasca sands, mining methods are uncertain because of the permafrost which extends to 1,600 feet. There is some suggestion that oil could be produced from this deposit by drilling holes below the 1,600-foot depth. If this proved successful, developers would then have to consider the economics of transporting the synthetic crude oil to markets.

## U.S. DEPOSITS

Although individual deposits in the U.S. are not as large as those in Canada, they occur in a number of widely scattered locations. The majority of deposits are in Utah, where the country's largest tar sands accumulation is located in the northeastern part of the state, near Asphalt Ridge in the Uinta basin. Here, the U.S. government is currently experimenting with methods of dislodging the oil from beneath its 200 feet of overburden through the use of combustion. No commercial operations have been launched in the U.S. to date but improved prices for crude oil are encouraging oil companies to take renewed interest in their leases.

Little information is available to researchers on tar sands activity in the U.S.S.R. It is known that commercial development has taken place in tar sands at Cheildag, near the Caspian Sea, where reserves are shallow. There is also speculation that a deposit in northeastern Siberia may prove comparable in size to the Athabasca deposit.

Elsewhere, the extent of deposits such as those near Burgan in Kuwait and in the Bolivar Coastal Fields of South America have not been fully assessed. More information on these and other deposits is expected to be made available as world energy demands become stronger and the need for new sources of crude oil grows.

It's not unreasonable to predict that, by the end of this century, a number of the world's major tar sands deposits will be making an important contribution toward meeting world energy demands.

rivière Orinoco a à peu près les mêmes dimensions que le plus grand des gisements de l'Alberta, mais on juge que l'épaisseur de la surcharge mesure 3,000 pieds à certains endroits, ce qui pourrait rendre l'extraction d'environ 200 milliards de barils de bitume brut extrêmement difficile.

En contraste, les gisements en Afrique, sur l'île de Madagascar dans l'océan indien, sont beaucoup plus petits que ceux du Venezuela et du Canada. Bien qu'ils couvrent seulement 150 milles carrés, le bitume semble relativement facile à extraire, puisque l'épaisseur de la surcharge varie de zéro à 100 pieds et peut être rejointe par une opération minière de surface.

Le gisement de l'île Melville, situé à quelque 1,450 milles au nord d'Edmonton, est intéressant à cause des conditions climatiques uniques qui y existent. Bien que l'épaisseur de la surcharge est à peu près la même que celle des sables bitumineux de l'Athabasca, les méthodes minières sont incertaines à cause du permafrost qui se rend jusqu'à 1,600 pieds. On suggère même qu'on pourrait produire du pétrole de ce gisement en forant des trous en dessous de la profondeur de 1,600 pieds.

Si ceci réussissait, les entrepreneurs devraient donc considérer la situation économique du transport du pétrole brut synthétique aux débouchés économiques.

## GISEMENTS DES ETATS-UNIS

Bien que les divers gisements aux Etats-Unis ne sont pas aussi grands que ceux du Canada, on les trouve dans nombre d'emplacements isolés les uns des autres. La majorité des gisements sont au Utah, où on trouve au nord-est de l'état, près de Asphalt Ridge dans le bassin Uinta, la plus grande accumulation de sables bitumineux du pays. Le gouvernement des Etats-Unis est à faire des expériences avec des méthodes qui délogent le pétrole d'en dessous de 200 pieds de surcharge en utilisant la combustion. Aucune opération commerciale n'a été lançée aux Etats-Unis jusqu'à date, mais de meilleurs prix pour le pétrole brut encouragent les compagnies pétrolières à reprendre intèrêt dans leurs concessions.

Il y a peu de détails disponibles aux chercheurs sur les activités dans les sables bitumineux de l'URSS. On sait qu'un certain développement commercial a eu lieu dans les sables bitumineux à Cheildag, près de la mer Caspienne, où les réserves sont peu profondes. Il existe une certaine spéculation qu'un gisement en Sibérie nord-est pourrait s'avérer comparable en dimensions au gisement de l'Athabasca.

Ailleurs, l'importance de gisements tels que ceux près de Burgan au Kuwait et dans les champs côtiers Bolivar en Amérique du Sud n'a pas été établie complètement. Plus de détails sur ceux-ci et d'autres gisements seront révélés lorsque les besoins énergétiques du monde deviendront plus intenses et la nécessité de trouver de nouvelles sources de pétrole brut s'imposera.

Ce n'est pas déraisonnable de prédire que d'ici la fin du siècle, un certain nombre des gisements importants de sables bitumineux au monde auront une contribution importante à faire pour rencontrer les besoins énergétiques du monde.

# THE LURE OF THE ATHABASCA TAR SANDS

*by Lois Bridges*

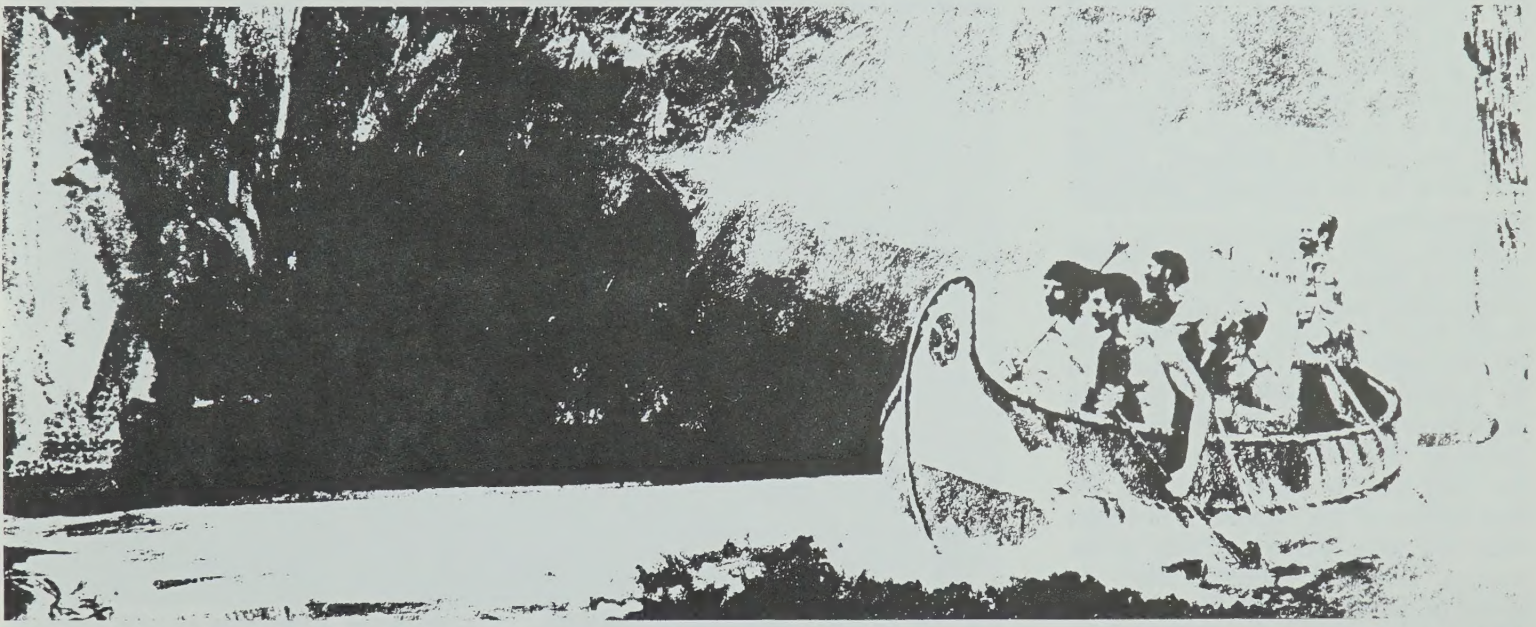
Travellers in the area of Alberta's Athabasca River never fail to be impressed by the towering banks of blackened sand that flank the river and its tributaries north of and south of the city of Fort McMurray.

Today, visitors realize they're viewing a true phenomenon of nature – one of the largest known bodies of oil-bearing sands in the world, the Athabasca Tar Sands.

Yet, less than a century ago, few people beyond the Indians of the area and a handful of explorers and trappers, even knew of the existence of this vast resource – and fewer still regarded it as anything more than a curiosity.

All of this was due to change, of course, but it didn't happen overnight. Although first scientific investigations of the sands in the 1880s hinted at their gigantic potential, it is only in the past few decades that any significant effort has been made to develop this vast resource.

Even during the years when Alberta was emerging as a major oil-producing province, there was little interest in the tar sands and their potential for the production of synthetic crude oil. The headlines then contained names like "Turner Valley" and "Leduc" – names that told of rich oil strikes and heralded an era of feverish activity in the province's conventional petroleum industry. What attention the tar sands did receive came largely from government scientific bodies and from a few hardy entrepreneurs who sensed the opportunity to "strike it rich" in this then-



*Peter Pond was one of the first Canadian explorers to report the existence of tar sands along the Athabasca River. (Painting by Bill McKibbin for Syncrude Canada Ltd.)*

*Peter Pond fut l'un des premiers explorateurs à rendre compte de l'existence des sables bitumineux le long de la rivière Athabasca (Tableau par Bill McKibbin pour Syncrude Canada Ltd.)*

# L'ATTRAIT DES SABLES BITUMINEUX DE L'ATHABASCA

*par Lois Bridges*

Les dominantes berges de sable noirci longeant la rivière Athabasca et ses affluents au nord et au sud de la ville de Fort McMurray, impressionnent toujours les voyageurs de passage.

Les visiteurs, aujourd'hui, réalisent qu'ils voient un phénomène vraiment naturel – l'une des plus grandes masse de sables oléagineux au monde, les sables bitumineux de l'Athabasca.

Pourtant il y a moins d'un siècle, très peu de gens, sauf les indiens de la région et quelques explorateurs et trappeurs, savaient que cette vaste ressource existait – et moins nombreux encore, ceux qui la considérait autre qu'une curiosité.

Tout ceci a été le résultat d'un changement d'attitude bien sûr, mais il ne s'est pas effectué du jour au lendemain. Quoique les premières investigations scientifiques des sables vers les 1880 font allusion à leur immense potentiel, c'est seulement depuis les quelques dernières décennies qu'un effort réel est fait afin de développer cette vaste ressource.

Même pendant les années où l'Alberta émerge en tant qu'une province productrice de pétrole importante, il existe peu d'intérêt envers les sables bitumineux et leur potentiel concernant la production du pétrole brut synthétique.

Les en-têtes comportent des noms tels que "Vallée Turner" et "Leduc" – noms qui représentent des forages de puits de pétrole riches et annoncent une période d'activité fiévreuse dans l'industrie provinciale conventionnelle du pétrole. L'intérêt porté aux sables bitumineux provient plutôt de la part des gouvernements et groupes scientifiques et de

remote region, about 250 miles northeast of Edmonton.

## PETER POND

It's likely the sands were first viewed by a white man in the latter part of the 18th century. Peter Pond, a New England fur trader and explorer, first saw the area in 1778. His journal reveals that the Cree Indians were well acquainted with the sands and had already found a good use for the sticky black substance that, on warm days, oozed from parts of the river bank.

Pond, who worked for the North West Company, was lured to the Athabasca by rumours of the rich harvest of furs to be taken in the area. The fur trading post he established at the junction of the Clearwater and Athabasca Rivers was known as the "Fort of the Forks". It was one of many to be built over the next hundred years in this strategic spot at the foot of a vast waterway leading to the Arctic. The last fort to be established on the site in 1870 was called Fort McMurray, a name that stuck to the settlement which later grew up there.

Eleven years after Pond reported seeing the sands, Alexander Mackenzie, a Scottish-born explorer and partner in the North West Company, visited the area. His first sight of the tar sands prompted the following description: "At about 24 miles from the fork are some bituminous fountains, into which a pole of twenty feet long may be inserted without the least resistance. The bitumen is in a fluid state, and when mixed with gum, or the resinous substance collected from the spruce fir, serves to gum the canoes. In its heated state it emits a smell like that of sea-coal".

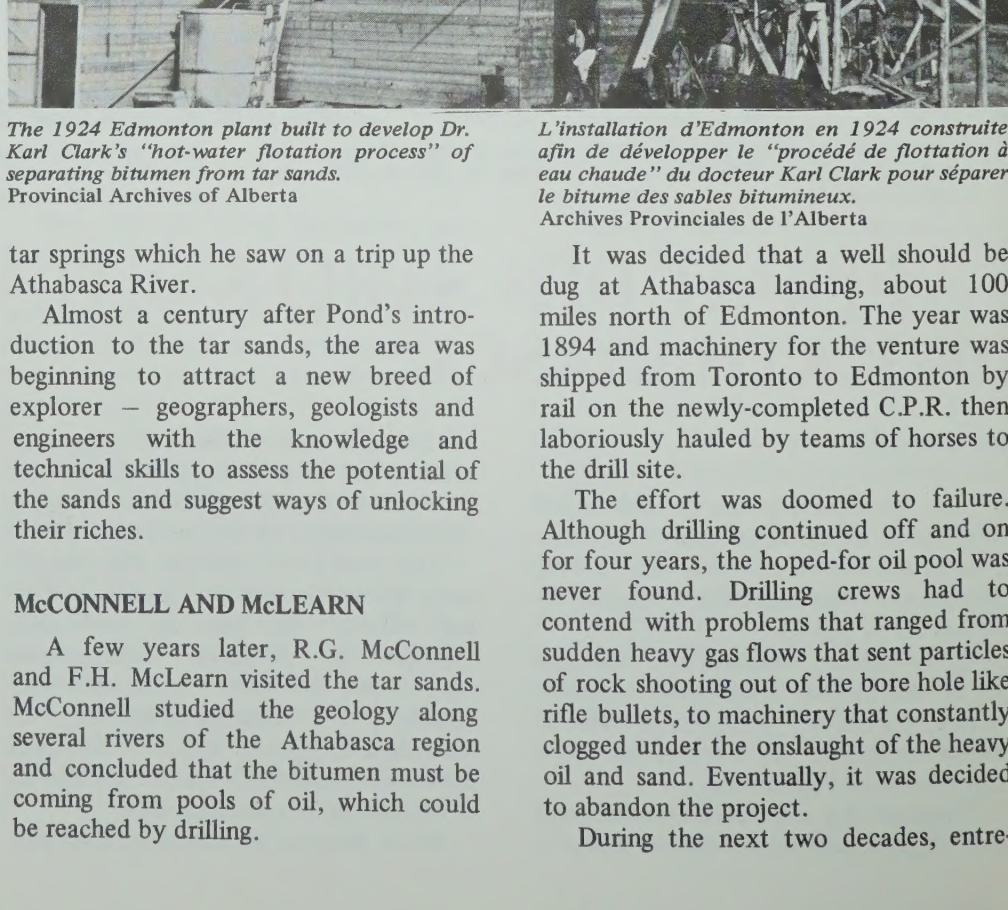
## DAVID THOMPSON

Other famous explorers were to view the tar sands over the next several decades. David Thompson, the noted mapmaker, surveyed the Athabasca River between the Clearwater River and Lake Athabasca in 1803. Later visitors to the bituminous sand country included Arctic explorers, Franklin, Richardson and Simpson.

These men were to be followed by others, less famous but no less hardy – fur traders, trappers, prospectors and adventurers. They did little to change the face of the land, however, and it was still a vast and virtually empty wilderness that greeted Prof. John Macoun of the Geological Survey of Canada when he arrived in the area in 1875. Macoun reported on the tar conglomerates, and tar springs which he saw on a trip up the Athabasca River.

*Some of the earliest samples of tar sand from the Athabasca area were brought out on pack dogs after the turn of the century. (Man lighting smoke may be Sidney Ells.)*
Provincial Archives of Alberta

*Les premiers prélèvements de sable bitumineux de la région de l'Athabasca ont été transportés en se servant de chiens au début du siècle. (Il se peut que l'homme s'allumant une cigarette soit Sidney Ells.)*
Archives Provinciales de l'Alberta



*The 1924 Edmonton plant built to develop Dr. Karl Clark's "hot-water flotation process" of separating bitumen from tar sands.*
Provincial Archives of Alberta

*L'installation d'Edmonton en 1924 construite afin de développer le "procédé de flottation à eau chaude" du docteur Karl Clark pour séparer le bitume des sables bitumineux.*
Archives Provinciales de l'Alberta

Almost a century after Pond's introduction to the tar sands, the area was beginning to attract a new breed of explorer – geographers, geologists and engineers with the knowledge and technical skills to assess the potential of the sands and suggest ways of unlocking their riches.

## McCONNELL AND McLEARN

A few years later, R.G. McConnell and F.H. McLearn visited the tar sands. McConnell studied the geology along several rivers of the Athabasca region and concluded that the bitumen must be coming from pools of oil, which could be reached by drilling.

It was decided that a well should be dug at Athabasca landing, about 100 miles north of Edmonton. The year was 1894 and machinery for the venture was shipped from Toronto to Edmonton by rail on the newly-completed C.P.R. then laboriously hauled by teams of horses to the drill site.

The effort was doomed to failure. Although drilling continued off and on for four years, the hoped-for oil pool was never found. Drilling crews had to contend with problems that ranged from sudden heavy gas flows that sent particles of rock shooting out of the bore hole like rifle bullets, to machinery that constantly clogged under the onslaught of the heavy oil and sand. Eventually, it was decided to abandon the project.

During the next two decades, entre-

*One of the first uses of tar sands bitumen was the experimental paving of an Edmonton street in 1915.*
**Provincial Archives of Alberta**

*L'une des premières utilisation du bitume provenant des sables bitumineux fut celle du revêtement d'une rue d'Edmonton en 1915.*

quelques entrepreneurs hardis qui pressentent l'occasion de s'enrichir dans cette région éloignée, à environ 250 milles au nord-ouest d'Edmonton.

## PETER POND

Il est possible que les sables ont été aperçus pour la première fois par un blanc vers la fin de 18ième siècle. Peter Pond, un négociant en fourrures et explorateur de la Nouvelle-Angleterre, a vu la région pour la première fois en 1778. Son journal intime révèle que les indiens "Cree" connaissent très bien les sables et on déjà trouvé une bonne utilisation pour cette substance gluante noire qui lors des journées chaudes, perce les berges de la rivière à certains endroits.

Pond, qui travaille pour la compagnie North West est attiré vers l'Athabasca par des rumeurs de riches récoltes de fourrures dans la région. Le poste de négociant en fourrures qu'il établit au confluent des rivières Clearwater et Athabasca est appelé le Fort des Fourches. Plusieurs autres postes seront construits durant les cent ans qui suivent à cet endroit stratégique, aux pieds d'un vaste cours d'eau menant à l'Arctique. Le dernier fort établi sur ce site en 1870 s'appelle Fort McMurray, et le nom est adopté par la colonie qui plus tard s'y développe.

Onze ans après que Pond rapporte avoir vu les sables, Alexander Mackenzie, un explorateur né en Ecosse et partenaire dans la compagnie North West, visite la région. La première fois qu'il voit les sables, la description suivante lui vient à l'esprit: "A environ 24 milles de la fourche, il existe des fontaines bitumineuses, dans lesquelles on peut insérer un poteau de 20 pieds sans aucune résistence. Le bitume est à l'étât fluide et lorsque mêlé à de la gomme, ou à une matière résineuse obtenue du sapin, sert à gommer les canoës. A son étât chauffé, il émet une odeur telle celle du charbon de mer."

## DAVID THOMPSON

D'autres explorateurs renommés doivent apercevoir les sables bitumineux au cours des décennies qui suivirent. David Thompson, le cartographe distingué, arpente la rivière Athabasca entre la rivière Clearwater et le lac Athabasca en 1803. Les visiteurs ultérieurs dans cette région de sables bitumineux incluent les explorateurs de l'Arctique, Franklin, Richardson et Simpson.

Ces hommes sont suivis par bien d'autres, moins connus mais non moins hardis – des négociants en fourrures, trappeurs, prospecteurs et aventuriers. Cependant, ils accomplissent peu afin de changer la surface du terrain et, c'est encore une région inexplorée vaste et presque désertique qui acceuille le professeur John Macoun de la Commission géologique du Canada, lorsqu'il arrive dans la région en 1875. Macoun présente un compte-rendu des conglomérats bitumineux, et sources bitumineuses qu'il aperçoit lors d'un voyage en amont sur la rivière Athabasca.

Presqu'un siècle après l'introduction de Pond aux sables bitumineux, la région commence à attirer un nouveau genre d'explorateur – géographes, géologistes et ingénieurs, doués de savoir et d'aptitudes techniques nécessaires afin de déterminer le potentiel des sables et de suggérer les façons de développer leur richesses.

## McCONNELL ET McLEARN

Quelques années plus tard, R.G. McConnell et F.H. McLearn visitent les sables bitumineux. McConnell étudie la géologie le long de plusieurs rivières de la région de l'Athabasca et conclue que le bitume doit provenir de mares de pétrole que l'on peut rejoindre en forant. On décide qu'un puits doit être creusé au débarcadère Athabasca, à environ 100 milles au nord d'Edmonton. On est en 1894, et la machinerie nécessaire à l'entreprise est expédiée de Toronto à Edmonton par voie ferrée, ensuite laborieusement tirée par des attelages jusqu'au site du forage.

L'effort est destiné à faillir. Quoique le forage continue par intervalles pendant quatre ans, la mare de pétrole espérée n'est jamais découverte. Des équipes de forage ont à faire face à des problèmes qui varient de grands flots soudains de gaz qui font éclater, tel que des balles de carabines, des parcelles de roc provenant du trou de forage, au problème de machinerie constamment bloquée de pétrole lourd et de sable. Eventuellement, on décide d'abandonner le projet.

Durant les deux décennies suivantes, l'entrepreneur le Comte Von Hammerstein et d'autres, relèvent le même défi et un certain nombre de trous sont forés dans les sables bitumineux et dans le calcaire de la région de l'Athabasca, mais on ne trouve rien d'importance économique, ni gaz ni pétrole.

## SIDNEY ELLS

Durant cette période, personne n'a été aussi intimement associé au développement des sables bitumineux que Sidney Ells, un jeune ingénieur du département des mines à Ottawa.

Convaincu des possibilités commerciales des sables bitumineux, Ells et son équipe rapportent les premiers prélèvements de sol de la région aux fins d'épreuves en laboratoire. Une année, les échantillons sont chargés sur un chaland mesurant 40 pieds, et tirés pendant 240 milles sur des eaux houleuses et des rapides; l'année suivante, plusieurs tonnes sont tirées sur le muskeg gelé et à travers

peneur Count Adolph Von Hammerstein and others took up the same challenge and a number of holes were drilled in the bituminous sands and limestone of the Athabasca region, but nothing of economic importance in the way of oil and gas was found.

## SIDNEY ELLS

During this era, no one was more closely associated with development of the sands than Sidney Ells, a young engineer with the department of mines in Ottawa.

Convinced of commercial possibilities for the sands, Ells and his crew brought out the first soil samples from the area for laboratory tests. One year, samples were loaded on a 40-foot scow and dragged up 240 miles of rough water and rapids; the next year, several tons were hauled by sleigh over frozen muskeg and through deep snow to Athabasca Landing, then brought by rail to Edmonton. As a result of Ells' work, it was decided to test the bituminous sand as road-paving material. Laid on a 618-yard stretch of the well-travelled Fort Trail in Edmonton in 1915, the material was reported to be holding up well some 15 years later. Early visions of the tar sands' potential for roadbuilding had been realized, but the problem of transporting the material to markets at a competitive price proved insurmountable. It couldn't compete with the price of imported asphalt.

Two main schools of thought emerged in the search for a viable method of extracting the bitumen from tar sand: the hot-water flotation advocates, and everyone else.

Ells was an early advocate of the hot water flotation, travelling to a research centre in Pittsburg, with tar sands samples in his luggage, to experiment with various types of flotation equipment. An independent entrepreneur, R.C. Fitzsimmons, raised money to build a small operating plant near Bitumount, about 50 miles north of Fort McMurray on the east bank of the Athabasca, in the early 1920's. For several years, Fitzsimmons' plant produced bitumen for roofing and road surfacing.

## KARL CLARK

And about the same time, the Alberta Government formed the Scientific and Industrial Research Council of Alberta to study development of the province's natural resources. One of its first projects was in the tar sands. By 1923, a young Council scientist, Dr. Karl Clark, had also begun experiments on hot-water flotation, experiments he carried on for more than 20 years.

All hot-water flotation processes basically worked on the same principle: tar sands were mixed with hot water to form a slurry, to which chemicals were sometimes added; this slurry, when introduced into a settling tank, would separate into a floating froth of bitumen, and a layer of clean sand which would settle to the bottom.

Hot-water flotation was not, and is not today, the only technique for prying bitumen from its sticky trap. Other techniques have included bombardment with ultrasonic radiation, combustion, solvent extraction and centrifugation, and a proposal (never acted on) for detonation of an atomic device in the deeply-buried tar sands to melt the bitumen. But, time and again, researchers returned to hot-water extraction as the most workable proposition.

The two decades between 1910 and 1930 saw the first flowering of scientific experimentation with these technologies. Then came the Depression. Both private and government funds for such projects suddenly dried up and interest in the tar sands once again dwindled. Frustrating as this must have been for the scientists and businessmen caught up in the excitement of developing new technology, the groundwork for future progress had been laid. By the time the first large-scale commercial venture, Great Canadian Oil Sands Ltd., began construction in 1964, the hot water process pioneered by Ells, Clark and Fitzsimmons was selected as the basis for the G.C.O.S. extraction process and is still in use today.

By the late 1930's, rumours of impending large scale developments in the sands were again circulating, and during the next couple of decades several experimental plants and commercial ventures were tried with varying degrees of success.

But it was not until the 1950's, when experts in the field began to point to the Alberta's dwindling conventional oil supplies, that industry and government began to make a concerted effort to tap this impressive alternative supply to petroleum. This renewed interest resulted in

*Fort McMurray's main street in the middle 1920s . . .*
Provincial Archives of Alberta

*La rue principale de Ft. McMurray vers le milieu des années 1920 . . .*
Archives Provinciale de l'Alberta

des neiges profondes, par traineaux, jusqu'au débarcadère Athabasca, ensuite expédiées par voie ferrée à Edmonton. Par suite du travail d'Ells, la décision est prise de faire l'épreuve du sable bitumineux en tant que matériel de revêtement des routes. Etendu sur un ruban de 618 verges sur un chemin bien voyagé du Fort en 1915, on rapporte que le matériel se maintient bien quelque quinze ans plus tard. Au début, on prévoyait que le potentiel des sables bitumineux pour la construction des routes avait été réalisé, mais le problème de transporter le matériel vers des débouchés dans les meilleures conditions rentables possibles, s'avère insurmontable. Il ne pouvait pas faire concurrence au prix de l'asphalte importée.

Deux genres d'opinions importantes émergent lors de la recherche en ce qui a trait à une méthode rentable d'extraire le bitume du sable bitumineux: les champions de la flottation à l'eau chaude et ceux qui restent.

Ells est un des premiers champions de la flottation à l'eau chaude, il voyage vers un Centre de recherches à Pittsburg, avec des échantillons de sable bitumineux dans ses bagages, pour faire des expériences avec différents genres de matériel de flottation. Un entrepreneur indépendant, R.C. Fitzsimmons, rassemble des fonds au début des années 1920 pour construire une petite usine d'opération près de Bitumount à environ 50 milles au nord de Ft. McMurray sur la rive est de l'Athabasca. Pendant plusieurs années, l'installation de Fitzsimmons produit du bitume pour le revêtement des routes et toits.

## KARL CLARK

Et environ au même moment, le gouvernement de l'Alberta forme le Conseil des recherches scientifiques et industrielles de l'Alberta afin qu'il étudie le développement des ressources naturelles de la province. Un des ses premiers projets avait lieu dans les sables bitumineux.

En 1923, un jeune scientifique du Conseil, le docteur Karl Clark a aussi commencé des expériences portant sur le procédé de flottation à l'eau chaude, expériences qu'il continue à faire pour plus de 20 ans.

Tous les procédés de flottation à l'eau chaude opérent généralement sur le même principe: les sables bitumineux sont mélangés à de l'eau chaude pour former un "slurry" (def.: un mélange généralement mince d'eau et d'un autre liquide ayant une substance finement divisée, tel le ciment, charbon, minerai, etc.) auquel on ajoute quelquefois des produits chimiques; ce "slurry", lorsqu'introduit dans un réservoir de stabilisation se sépare en écume de bitume qui flotte, et une couche de sable propre qui repose au fond.

La flottation à l'eau chaude n'était pas et, n'est pas aujourd'hui, la seule technique pour soustraire le bitume de de son piège gluant. D'autres techniques incluent un bombardement de radiation ultrason, la combustion, l'extraction et centrifugation avec des dissolvants, et la proposition (jamais rélevée) de détoner un appareil atomique dans les sables profondément enfouis, afin de faire fondre le bitume. Mais, toujours, les chercheurs retournent à l'extraction à l'eau chaude, car celle-ci est la proposition la plus practicable.

Les deux décennies entre 1910 et 1930 ont vu l'épanouissement de l'expérimentation scientifique grâce à ces technologies. Puis arrive la dépression. Les fonds gouvernementaux et privés pour de tels projets se sont soudainement trouvés à sec et l'intérêt porté aux sables bitumineux diminue de nouveau. Bien que ceci doit être bien frustrant pour les scientifiques et hommes d'affaires désireux de développer une nouvelle technologie, le travail de base pour des projets futurs est accompli. Lorsque la première entreprise commerciale de grande envergure, Great Canadian Oil Sands Ltd., commence la construction en 1964, le procédé de flottation à l'eau chaude développé par Ells, Clark et Fitzsimmons est choisi en tant que base pour le procédé d'extraction de G.C.O.S. et est encore utilisé aujourd'hui.

Avant la fin des années 1930, des rumeurs de développements de grande envergure circulaient constamment et durant les deux prochaines décennies, on tente plusieurs installations expérimentales et entreprises commerciales obtenant des succès variés.

Mais c'est seulement dans les années 1950, lorsque des experts dans le domaine commencent à mentionner que les provisions conventionnelles diminuent, que l'industrie et le gouvernement font un effort d'ensemble pour utiliser

*. . . contrasts sharply with the rapidly growing modern urban centre that is becoming one of the largest communities in Alberta.*

*. . . est grandement en contraste avec le centre urbain modern, toujours croissant, qui devient l'un des plus grands centres de l'Alberta.*

today's developments which include one operating plant (G.C.O.S.) and one scheduled to begin operation in 1978 (Syncrude Canada Ltd.).

## VON HAMMERSTEIN

If early drilling crews failed to make a significant strike in the tar sands, at least one commercial benefit resulted from their efforts. Count Von Hammerstein, working in the Athabasca River area in 1906, found – not the oil he was seeking – but several hundred feet of salt. The discovery led to the construction of a salt plant at the mouth of the Horse River during the 1920's. Later drilling at Waterways, near Fort McMurray, revealed more salt (deposits were estimated at 30 million tons) and area residents began to talk about the possibility of the town becoming "The Salt Capital of the World".

A plant built by Dominion Tar and Chemical operated there until 1950, when competition from new salt plants further south forced it to close.

A disastrous fire in 1871 and floods and ice jams on the Athabasca in 1875 virtually wiped out the town, but somehow it managed to survive. Perhaps it was the encouraging reports that followed periodic mineral surveys in the area that kept the townspeople there, hopeful of better times in the future.

From the completion of the railway to nearby Waterways in 1922 until the development of an alternative route in the late 1950's, McMurray was a key link in the major transportation route to the high Arctic; goods arriving by train in Waterways were loaded onto barges for river transportation north to the mighty Mackenzie. Lumbering, fur-trading and fresh-water fishing also contributed to the local economy. By the early 1930's famous bush pilots like "Wop" May and "Punch" Dickens began regular air service to the community.

During World War Two, there was a brief flurry of activity in the town when the area served as a base for the CANOL pipeline project to supply Alaska military airfields with oil from Norman Wells, N.W.T.

Although this activity also subsided after the war, Fort McMurray was no longer the isolated community it once had been. Now, all that was needed to increase the area's accessibility was a good road. Developments in the oil sands during the 1960's made this even more of a necessity and in 1963, a route was chosen for a new highway to replace the low-grade forestry road which was once the only surface route to the south. Problems of building a highway over miles of muskeg slowed the project, but by the winter of 1966 a "passable" road had been built and by 1975, paving was complete.

Since that time, launching of the massive Syncrude tar sands development at Mildred Lake has made Highway 63 between Edmonton and Fort McMurray one of the busiest in the province.

After so many decades of hope and disappointment, Fort McMurray's future finally seems assured. Present and future developments in the region are expected to push the current population of 14,000 to over 25,000 by the late 1970's. By the end of this century, it's possible Fort McMurray will be one of Alberta's largest cities.

cette source alternative impressionante de pétrole. De ce renouvellement d'intérêt, résulte les développements d'aujourd'hui qui incluent une installation présentement active (G.C.O.S.) et une autre qui doit être en marche en 1978 (Syncrude Canada Ltd.).

## VON HAMMERSTEIN

Si les premières équipes de forage n'ont pas fait de rencontre importante dans les sables bitumineux, un bénéfice commercial résulta au moins de leurs efforts. Le Comte Von Hammerstein, travaillant dans la rivière Athabasca en 1906 trouve – non pas le pétrole qu'il cherche – mais plusieurs centaines de pieds de sel. La découverte entraîne la construction d'une usine d'extraction de sel à l'embouchure de la rivière Horse durant les années 1920. Plus tard, on trouve du sel en forant à Waterways, près de Fort McMurray (des gisements d'environ 30 millions de tonnes) et les habitants de la région commencent à discuter de la possibilité que la ville devienne "la capitale mondiale du sel".

Une usine construire par Dominion Tar and Chemical y opère jusqu'en 1950, lorsque la concurrence de nouvelles usines de sel, plus au sud, la force à fermer ses portes.

Un incendie en 1871, des innondations et des embâcles sur l'Athabasca en 1875 ont déjà presqu'anéanti la ville, mais elle a survécu, tant bien que mal. C'est peut-être à cause de rapports encourageants à la suite de relevés minéraux dans la région, que les habitants y demeurent, espérant de meilleurs jours à venir.

En partant du fait que le chemin de fer est complété jusqu'à Waterways, tout près, en 1922, jusqu'au développement d'une route alternative vers la fin des années 1950, McMurray est un maillon important de la grande route de transport jusqu'à l'Arctique; les marchandises qui arrivent par train à Waterways sont chargées sur des barges pour le transport fluvial vers la puissante Mackenzie au nord. L'exploitation de bois d'oeuvre, le commerce de fourrures et la pêche à l'eau douce contribuent à l'économie locale. Vers le début des années 1930, des pilotes de brousses renommés, tels que "Wop" May et "Punch" Dickens commencent à offrir un service aérien régulier dans la région.

Durant la deuxième guerre mondiale, il y a un brève moment d'activité dans la ville, lorsque la région sert de base pour le projet de pipe-line CANOL qui approvisionne les terrains d'aviation militaires de l'Alaska, du pétrole de Norman Wells, Territoires du Nord-Ouest.

Bien que cette activité aussi diminue après la guerre, Ft. McMurray n'est plus la ville isolée qu'elle était auparavant. Maintenant, tout ce qu'il fallait pour que la région soit plus accessible était une bonne route. Les développements des sables oléagineux durant les années 1960 rendent ceci encore plus nécessaire et, en 1963, on choisit le parcours d'un nouvelle autoroute qui remplacera la route forestière qui était autrefois la seule route de surface vers le sud. Les problèmes qui se présentent lorsqu'on construit une autoroute à travers des milles de muskeg ralentissent le project, mais à l'hiver de 1966, une route "passable" est construite et en 1975, le evêtement est terminé.

Depuis ce temps, le lancement de l'immense développement des sables bitumineux Syncrude à Mildred Lake, a rendu l'autoroute 63 entre Edmonton et Ft. McMurray, l'une des plus voyagées de la province.

A la suite de tellement d'années remplies d'espoir et de contretemps, l'avenir de Ft. McMurray semble assuré. On s'attend à ce que les développements présents et futurs dans la région augmenteront la population actuelle de 14,000 à plus de 25,000 d'ici les années 1970. D'ici la fin du siècle, c'est possible que Ft. McMurray soit l'une des plus grandes villes de la province.

# Mining Extraction Upgrading

*by Tudor Williams*

Tar sand is a mixture of sand, heavy oil, mineral-rich clays and water. The Athabasca Tar Sands are found in two geological formations, the McMurray and the Clearwater. The precise age of these formations has not yet been determined, but is thought to be about 200 million years. The thickness of these formations rarely exceeds 200 feet.

Sand particles make up about 84% of tar sand by weight. These particles consist predominantly of quartz, with traces of mica, rutile, zircon, tourmaline and pyrite.

The heavy oil in tar sand averages about 12% by weight, and is called bitumen. Raw bitumen is a sticky black semi-solid with a distinctive smell. Its viscosity is so high that it will not flow at room temperature. For this reason, bitumen cannot be pumped through a pipeline, or even readily handled, unless it is either diluted with a solvent, or kept in a heated condition.

Raw bitumen has a very high carbon content (83.3% by weight), as the accompanying table indicates. Oil compounds account for the largest proportion (50-60%), with resins (30-35%) and asphaltenes (15-25%) accounting for the remainder. The density of bitumen is slightly greater than water at room temperature, but this reverses at temperatures between 50°C and 100°C. Its density is measured on the API (American Petroleum Institute) scale at about 9°, compared with a conventional crude oil, such as Redwater crude, which has an API of 35°.

## WATER ENVELOPE

Water is also present in the tar sands as a dispersed phase and as bulk water. An important fact about tar sand is that the wet oil does not adhere directly to the

# Travail des mines Extraction Transformation

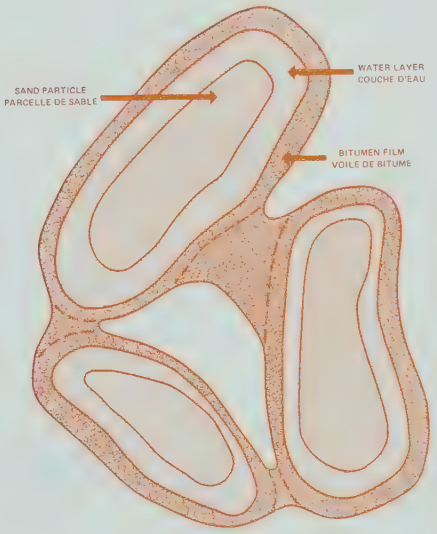
*par Tudor Williams*

Le sable bitumineux est un mélange de sable, de pétrole lourd, d'argiles riches en minéraux et d'eau. On trouve les sables bitumineux de l'Athabasca dans deux genres de plis géologiques, le McMurray et le Clearwater. L'âge précis de ces plis n'a pas encore été déterminé, mais on croit qu'ils existent depuis 200 millions d'années. La profondeur de ces plis excède rarement plus de 200 pieds.

Environ 84% du poids du sable bitumineux consiste de parcelles de sable. Ces parcelles sont composées primordialement de quartz avec un peu de mica, de rutile, de zircon, de tourmaline et de pyrite.

Le pétrole lourd dans le sable bitumineux représente en moyenne 12% du poids, et s'appelle bitume. Le bitume brut est un semi-solide gluant noir ayant une odeur distincte. Sa viscosité est tellement élevée qu'il ne coulera pas à la température de la pièce. Pour cette raison, le bitume ne peut pas être pompé par pipe-line, ou même manié facilement, à moins qu'il soit dilué avec un dissolvant ou gardé chaud.

Le bitume brut contient beaucoup de carbone (83.3% du poids), tel que l'indique le tableau ci-joint. Les composés de pétrole représentent la plus grande proportion (50-60%), les résines (30-35%) et l'asphaltite (15-25%) représentent le reste. La densité du bitume est légèrement plus grande que celle de l'eau à la température de la pièce, mais c'est le contraire lorsque les températures sont entre 50°C et 100°C. Sa densité est mesurée à l'aide de l'échelle API (American Petroleum Institute) à environ 9°, parallèlement au pétrole but conventionnel, tel que le brut Redwater qui mesure 35° API.

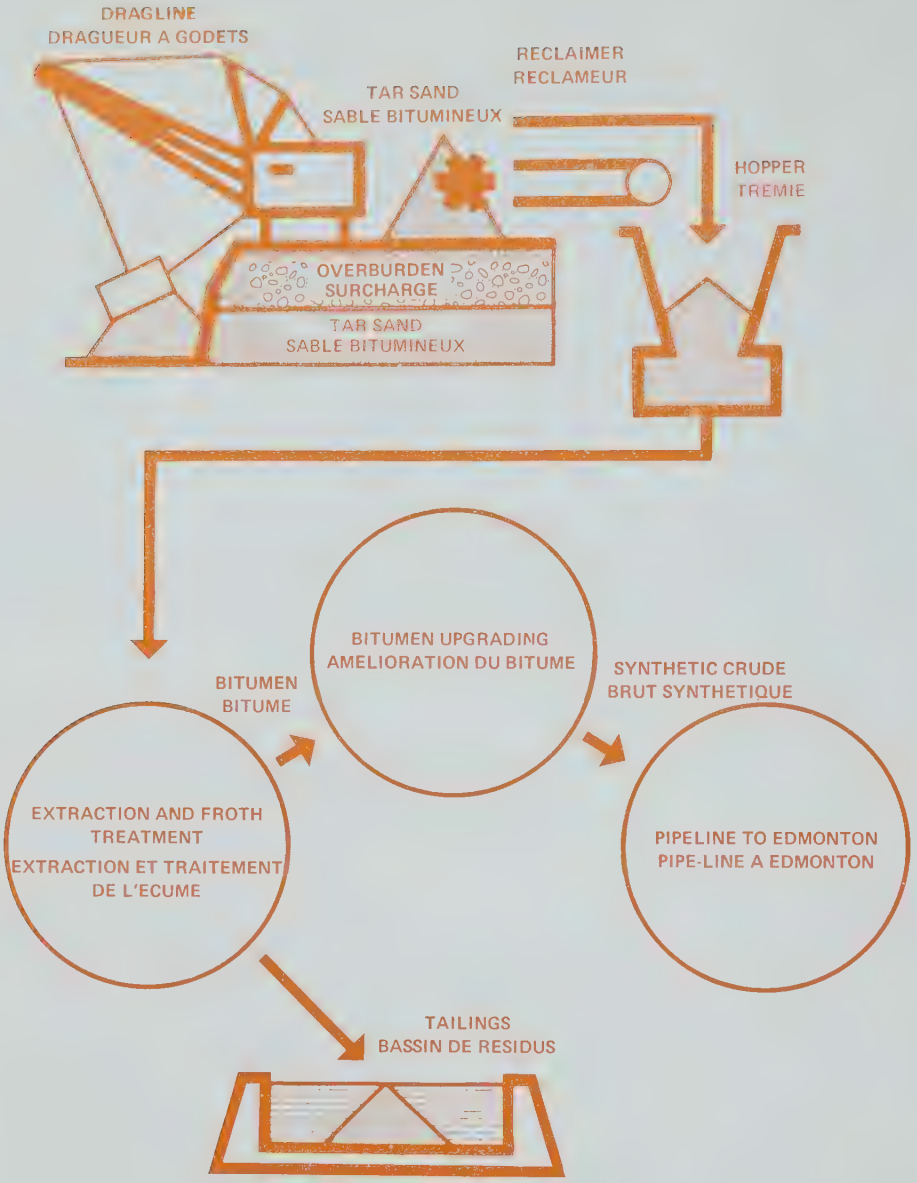



**CROSS SECTION OF TAR SANDS SAMPLE**
**COUPE TRANSVERSALE D'UN ECHANTILLON DE SABLE BITUMINEUX**

## L'ENVELOPPE D'EAU

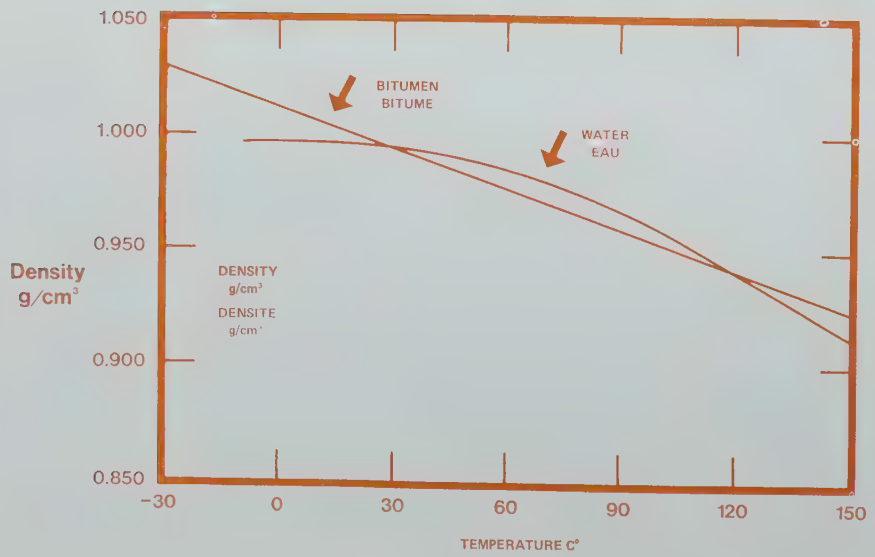
On trouve aussi de l'eau dans les sables bitumineux en phase dispersée et en masse. Un fait important à noter au sujet du sable bitumineux est que le pétrole mouillé n'adhère pas directement aux grains de sable car un filet d'eau entoure chaque grain et il s'insinue entre le bitume et la surface du grain de sable; ce phénomène devient essentiel lorsqu'on sépare le bitume du sable bitumineux durant le procédé de transformation. Sans l'enveloppe d'eau, le pétrole continuerait à adhérer aux grains de sable.

La composition du sable bitumineux est en moyenne: 84% de sable, argile et minéraux, 12% de bitume et 4% d'eau.




**BLOCK FLOW DIAGRAM**

**DIAGRAMME DE PASSAGE SOMMAIRE**




**DENSITY OF BITUME WATER vs TEMP.**

**DENSITE DU BITUME DE L'EAU vs TEMP.**

(Ces chiffres sont basés sur la pesanteur.)

A cause de son extrême viscosité, la quantité importante de carbone, et plusieurs impuretés tels que des composés de soufre, le bitume brut a très peu de valeur commerciale, sauf en tant que matériel brut pour la production de pétrole brut synthétique. Le procédé pour le transformer en pétrole brut synthétique consiste de deux phases: (1) extraire le bitume du sable bitumineux et, (2) améliorer le bitume en brut synthétique.

Après que le sable a été miné et transporté à l'installation d'extraction, on alimente un culbuteur rotatoire de sable bitumineux, où il est mélangé à de l'eau chaude (80°C) et à de la vapeur (en raison de deux parties de sable bitumineux pour une partie d'eau, selon la pesanteur); un peu d'hydrate de sodium est ajoutée pour faire monter la valeur pH de 7 à 8.5 (le pH du sable bitumineux récemment miné). Ce mélange donne le "slurry" (def: un mélange généralement mince d'eau et d'un autre liquide ayant une substance finement divisée, tel le ciment, charbon, minerai etc.). Le voile extérieur de bitume est rompu et le bitume se sépare du sable bitumineux et forme des globules ou gouttes individuelles. On alimente ensuite le "slurry" à une cellule d'extraction, dans laquelle les gouttes de bitume aéré flottent à la surface et forment de l'écume que l'on enlève.

## FORMATION D'ECUME

L'optimum des conditions pour la formation d'écume est à une température d'environ 80°C, lorsque le bitume est moins épais que l'eau et donc flotte, et une solution pH élémentaire qui a tendance à porter au maximum la grosseur des gouttes de bitume.

L'écume qui résulte consiste d'environ 55%-60% de bitume, et contient toujours de l'eau et des minéraux. Elle est diluée avec du naphte et est centrifugée d'abord à basse vitesse pour enlever le sable ordinaire, ensuite à haute vitesse pour séparer le bitume des minéraux purs et de l'eau. Le naphte est ensuite enlevé par distillation.

On utilise de grandes quantités d'eau dans le procédé d'extraction et 55%-65% est recyclée. Le reste, qui contient des parcelles de colloïde est mis en réserve dans le bassin de résidus. Le système est fermé et aucune quantité d'eau utilisée dans le procédé ne se déverse dans les rivières et lacs en dehors du système.

## TRANSFORMATION

On doit donc maintenant transformer le bitume pur très visceux, ce qui est fait en deux étapes:

(1) *le coking*, pour transformer des résidus non-distillables (environ 50% du bitume) en formes distillables pour un traitement supplémentaire, et;

(2) *le traitement à l'eau* pour transformer ces produits en un mélange de produit acceptable, et de les rendre suffisamment stables pour pouvoir les transporter. La majeure partie du soufre et du nitrogène est aussi retirée à cette étape.

On utilise actuellement ou on utilisera, deux genres de procédés de coking:

(1) *le coking à retardement* (utilisé en ce moment par Great Canadian Oil Sands Ltd.) Ceci se poursuit en deux étapes: le bitume est rapidement chauffé dans un four d'alimentation et ensuite repose pour un certain temps dans des bidons de coke où les grandes molécules de bitume sont craquées en plus petites molécules, formant ainsi des produits distillables: le naphte, le kérosène et le gas-oil.

(2) *le coking fluide* (que Syncrude Canada Ltd. doit utiliser) Le réacteur de coking contient de fines parcelles de coke en mouvement rapide dans un gas (coke "fluide") à environ 500 C dans lequel on alimente le bitume et de la vapeur. Le bitume se vaporise et craque en contact avec le coke et on alimente les produits vers le traitement "en aval". On brûle du coke dans un four séparé pour fournir la chaleur nécessaire aux réactions de cracking. Le gas produit est traité à l'amine pour retirer le gas sulfure d'hydrogène ($H_2S$) et utilisé comme carburant pour l'usine. Les produits de coking contiennent encore beaucoup de soufre et de nitrogène. Dans les bloc-hydrotreating, ceux-ci sont retirés et un mélange acceptable de naphte et de gas-oil est préparé pour transmettre par pipe-line.

## CARACTERISTIQUES

Le pétrole brut synthétique est primordialement un mélange de naphte et de gas-oil d'environ 30° API. La portion de naphte a tendance à être plus paraffinée et moins aromatique que le naphte à raffiner ordinaire. Ceci indique que la portion de naphte pourrait être une base d'alimentation supérieure pour l'ethylène mais inférieure pour le benzène, toulène et xylène lorsque comparée à des bases d'alimentation conventionnelles.

Les gas-oils légers contiennent une proportion importante d'"alkanes" et les gas-oils contiennent des quantités importantes de paraffines. Ceci semble indiquer que ceux-ci pourraient être utilisés dans des raffineries conventionnelles en tant que bases d'alimentation pour des procédés conventionnels, tels que le "cat-cracking" pour la production de la gazoline et l'essence aviation.

Le pétrole brut synthétique donc fournit une base d'alimentation de bonne qualité et contenant peu de soufre pour les raffineries actuelles et offre aussi des occasions pour des utilisations futures dans l'industrie pétrochimique toujours croissante au Canada.

| Elemental Analysis, Wt% | | Analyse des éléments, Poids % |
|---|---|---|
| Carbon | 83.2 | Carbone |
| Hydrogen | 10.4 | Hydrogène |
| Oxygen | 0.94 | Oxygène |
| Nitrogen | 0.36 | Nigrogène |
| Sulphur | 4.2 (3.8-5.5) | Soufre |
| Metals, ppm | | Métaux, ppm |
| Vanadium | 250 | Vanadium |
| Nickel | 100 | Nickel |
| Copper | 5 | Cuivre |
| Ash, Wt % | 0.65 | Cendres, pds. % |
| Hydrocarbon type, Wt% | | Type hydrocarbure, pds. % |
| Asphaltenes | 19 | Asphaltite |
| Polar Aromatics | 32 | Aromatiques polaires |
| Aromatics | 30 | Aromatiques |
| Saturates | 19 | Saturés |
| Gravity | 6.5° API | Gravité |

sand grains because a film of water surrounds each grain and comes between the bitumen and the surface of the sand grain; this phenomenon becomes vital in separating the bitumen from the tar sand during processing. Without the water envelope, the oil would continue to adhere to the sand grains.

The composition of tar sand is, on the average: 84% sand, clay and minerals, 12% bitumen and 4% water (Figures by weight).

Because of its high viscosity, high carbon content, and many impurities such as sulphur compounds, raw bitumen has very little commercial value except as a raw material for making synthetic crude oil. The process of transforming it into synthetic crude oil consists of two phases: (1) extraction of the bitumen from tar sand, and (2) upgrading of the bitumen into synthetic crude.

After tar sand has been mined and transported to the extraction plant, it is fed into a rotating tumbler where it is mixed with hot water (80°C) and steam (in a ratio of two parts of tar sand to one part of water, by weight); a small amount of sodium hydroxide is added to bring the pH value from 7 (the pH of freshly-mined tar sand) to 8.5. This mixture forms the "slurry". The outer bitumen film is ruptured and the bitumen separates from the tar sand and forms individual globules or droplets. The slurry is then fed into an extraction cell where the droplets of aerated bitumen float to the surface and form a froth, which is skimmed off.

## FROTH FORMATION

The optimum conditions for froth formation are a temperature of approximately 80°C, at which point bitumen is less dense than water and thus floats, and a slightly basic pH solution which tends to maximize the size of bitumen droplets.

The resulting froth consists of about 55% - 60% bitumen and still contains water and some minerals. It is diluted with naphtha and centrifuged first at low speed to remove course sand, then at high speed to separate the bitumen from the fine minerals and water. The naphtha is then removed by distillation.

Large amounts of water are used in the extraction process and 55% - 65% is recycled. The remainder, containing colloidal fines (particles) is stored in the tailings pond. The system is closed and no process water is discharged to rivers or lakes outside the system.

## UPGRADING

The highly viscous raw bitumen now requires upgrading which is performed in two steps:

(1) *coking*, to convert non-distillable residues (about 50% of bitumen) to distillable forms for further processing and;

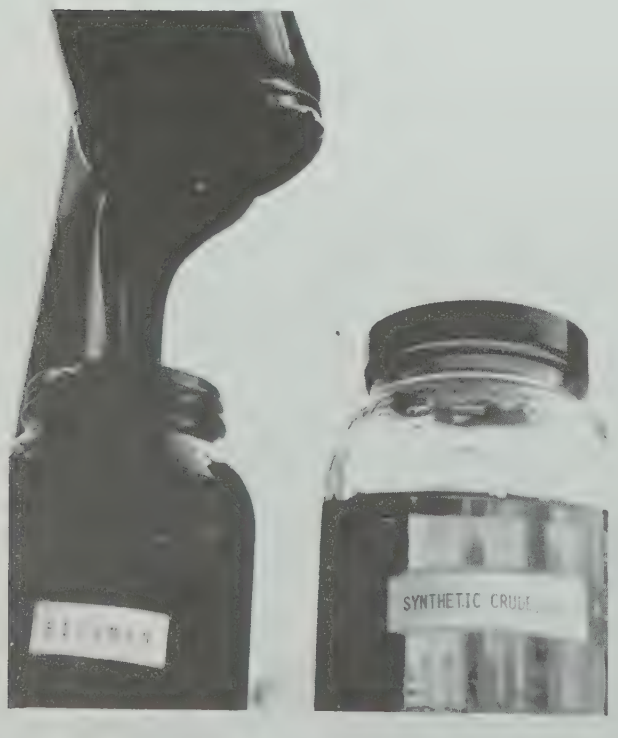
(2) *hydrotreating*, to convert these products to an acceptable product mix, and to make them stable enough for transportation. Most of the nitrogen and sulphur is also removed at this stage.

Two types of coking procedures are being or will be used:

(1) *Delayed coking* (currently being used by Great Canadian Oil Sands Ltd.) This proceeds in two stages; the bitumen is rapidly heated in a feed furnace, and then resides for a time in coke drums where the large bitumen molecules are cracked into smaller ones, thus forming distillable products: naphtha, kerosene and gas oil.

(2) *Fluid coking* (to be used by Syncrude Canada Ltd.) The coker reactor contains fine coke particles in rapid motion in a gas ("fluid" coke) at about 500C into which bitumen and steam are fed. The bitumen vaporizes and cracks on contact with the coke and the products are fed to down-stream processing. Some coke is burned in a separate burner to provide the heat needed for the cracking reactions. The process gas produced is amine-treated to remove hydrogen sulfide gas ($H_2S$) and used as fuel for the plant.

The products of coking are still high in sulphur and nitrogen. In the hydrotreating units these are removed and an acceptable mix of naphtha and gas oil prepared for transmission by pipeline.




*Thick heavy bitumen separated from tar sand compared with the final product of synthetic crude oil.*

*Le bitume épais et lourd séparé du sable bitumineux en comparaison avec le produit fini, le pétrole brut synthétique.*

## CHARACTERISTICS

Synthetic crude oil is essentially a mixture of naphtha and gas oils with an API of approximately 30°. The naphtha portion tends to be more paraffinic and less aromatic than regular refining naphtha. This indicates that it could be a superior feedstock to ethylene but inferior for benzene, toluene and xylene when compared to conventional feedstocks.

The light oils contain a significant proportion of alkanes and the gas oils contain significant amounts of paraffins. This would indicate that these could be used in conventional refineries as feedstocks for conventional processes such as cat cracking for the production of gasoline and aviation fuel.

Synthetic crude oil thus provides a high quality, low sulphur feedstock for existing refineries and also offers opportunities for many future uses in the growing Canadian petrochemical industry.

# Dreams of Development

*by Lois Bridges*

For nearly a century, commercial development of the Athabasca Tar Sands has been a dream of industry, government and private individuals.

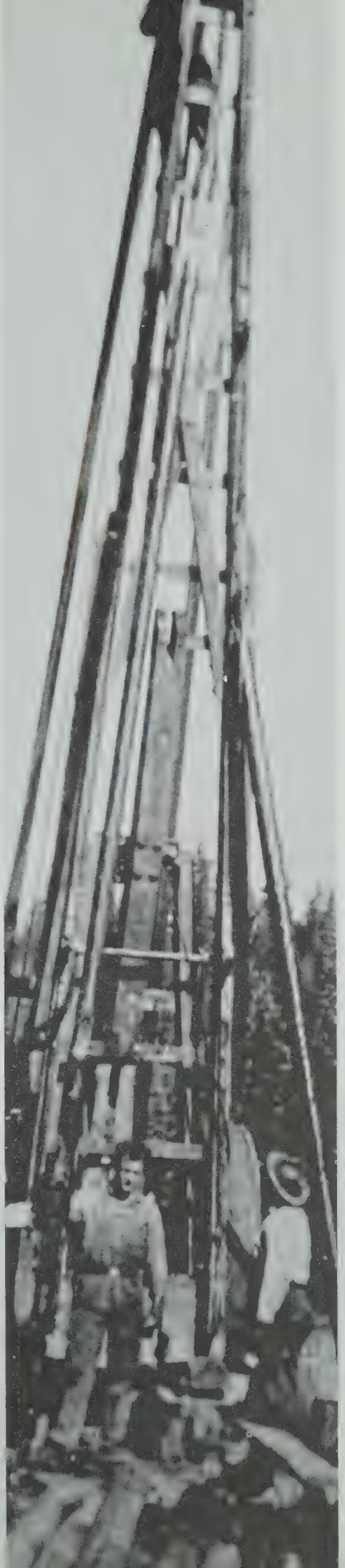
Unfortunately, more often than not, that is precisely what a number of early development schemes turned out to be – elusive dreams that, for one reason or another, always fell short of realization.

For decades, even those projects which were backed by careful research and ample funding seemed doomed to failure, a fact that must have been doubly frustrating for men of vision who realized the sands would one day release their treasure to a new generation of developers, armed with improved technology.

The first technical study of the tar sands began in 1875 when John Macoun of the Geological Survey of Canada travelled the Athabasca River. He was followed, seven years later, by geologist Robert Bell and, in 1888, by R.G. McConnell. The latter believed petroleum in the fluid state could be obtained by drilling into the oil sands. As a result, a well was drilled at Pelican Rapids, about 100 miles upstream from Fort McMurray, but the result was only a flow of gas, no oil.

In 1906, a German aristocrat, Count Alfred von Hammerstein, continued the search for the pool of oil which was thought to be the source of the bitumen. He drilled a series of holes along the Athabasca River but was also unsuccessful.

S.C. Ells, an official of the federal mines branch, began his work on the tar sands in 1913, when it was thought the most logical use of the material was for



*R.C. Fitzsimmons' 1923 drilling – searching for the elusive pool of "free" oil many believed existed beneath the tar sands.*
Provincial Archives of Alberta

# Rêves du développement

*par Lois Bridges*

Pendant presqu'un siècle, l'industrie, le gouvernement et les individus rêvent de développer commercialement les sables bitumineux de l'Athabasca.

Malheureusement, très souvent c'est exactement ce que les premiers systèmes de développement étaient – des rêves illusoires qui, pour une raison ou une autre, n'étaient pas tout à fait réalisables. Pendant des décennies, même les projets appuyés par des recherches approfondies et des fonds abondants, semblaient destinés à faillir, un fait qui a du être doublement frustrant pour les hommes de grande perspicacité qui réalisaient que les sables offriraient un jour leur trésor à une nouvelle génération d'entrepreneurs, armés d'une nouvelle technologie.

La première étude technique des sables bitumineux commence en 1875 lorsque John Macoun de la Commission géologique du Canada voyage sur la rivière Athabasca. Il est suivi, sept ans plus tard, par le géologiste Robert Bell et, en 1888, par R.G. McConnell. Ce dernier croit que le pétrole à son état fluide peut être obtenu en forant dans les sables oléagineux. Comme résultat, un puits est foré à Rapides Pélican, environ 100 milles en amont de Fort McMurray, mais un flot de gaz seulement, et non de pétrole résulte.

En 1906, un aristocrate allemand, le comte Alfred von Hammerstein continue à la recherche de la mare de pétrole, laquelle croit-on est la source du bitume. Il fore une série de trous le long de la rivière Athabasca mais, lui aussi, n'obtient aucun succès.

S.C. Ells, un officier du département fédéral des mines, commence son travail

*Le forage de R.C. Fitzsimmons en 1923 – à la recherche de la mare "libre" de pétrole difficile à trouver qui selon plusieurs personnes existait sous les sables bitumineux.*
Archives Provinciales de l'Alberta

road surfacing. He studied the area from this viewpoint and was successful in utilizing the sand for this purpose. His major contribution to the development of the sands, however, was his survey of the area. His corner posts, maps (including topography) and recorded elevations proved invaluable to later developers.

### R.C. FITZSIMMONS

R.C. Fitzsimmons continued the search for the pool of "free" oil through conventional drilling in 1923. By 1930 he realized this was impractical and new methods had to be developed. He set up a small separation plant at Bitumount where he mined the sands and separated out the bitumen, using a hot water process.

Although he gradually expanded and improved his plant and achieved some success in making distillate and asphalt, financial difficulties forced Fitzsimmons to sell his company in 1942. Its new owners named it Oil Sands Limited.

Despite a provincial government loan and technical support, Fitzsimmons' successors also ran into money problems and by 1948 the Bitumount plant had been taken over by the Alberta government.

In 1949, the plant was separating 500 tons of oil sand per day. The Bitumount operation had proved it was technically possible to separate oil from the sand. The economics of the operation needed further study, however, and since the government was not interested in launching a commercial venture, the plant was closed.

During this time, development was taking place elsewhere in the sands. Since its establishment in 1919, the Alberta Research Council had been studying tar sands recovery in its Edmonton laboratory and in the field and, in 1929, it established a small pilot plant at Waterways near Fort McMurray. Working in co-operation with the federal government mines branch, the Research Council mined the sands and separated out the bitumen using a hot-water-washing method. Road surfacing material produced by these experiments was used on Edmonton streets.

### ABASAND OILS LTD.

About this time, Max Ball became interested in the tar sands. He and a group of Denver businessmen tried to purchase the Research Council's pilot plant but were unable to raise the needed funds. Ball persisted, however, and by 1936 his company, Abasand Oils Ltd., was established in the valley of the Horse River, south of McMurray. Using a modified hot water process, and a simple refinery, Ball was successful in producing a diesel oil product that was shipped by pipeline and barge to mining camps on Lake Athabasca.

By 1941, Canada was in the midst of a war and the federal government concerned that the Japanese would interfere with west coast fuel supplies, began to look more seriously at tar sands development. A team of observers was sent to the Abasand plant to assess its progress. Encouraged by this interest, Ball sought to improve his process and received permission from his backers to dismantle and reassemble the plant to operate more efficiently.

Before this was achieved, however, several changes had taken place. The wartime emergency was over; Ball returned to the U.S. on a government assignment; and the Canadian government took over Abasand. Although the plant was eventually reassembled, it never seemed to work as well as it had under Ball's guidance. In 1945, a spark from a welder's torch ignited the plant and it burned to the ground. The plant was never rebuilt – and another era in commercial development came to a close.

### ECONOMIC FEASIBILITY

In 1950, the results of a government-industry study (The Blair Report) on the economic feasibility of developing the sands showed that, if a plant could be built to produce 20,000 or more barrels of synthetic crude per day, it would very likely prove to be a profitable venture.

Industry began to take a more positive approach toward large-scale commercial development of the tar sands. One of the first oil companies to show an interest was Cities Service Co., which formed a subsidiary, Cities-Service Athabasca Inc., to establish a 1000-barrel-a-day pilot plant at Mildred Lake, about 25 miles north of Fort McMurray. The plant experimented with mining, materials handling and extraction techniques and, at its peak, employed about 150.

During the early years of tar sands investigation, the government had been lenient with speculators, but it gradually became obvious that a system of leases and permits would have to be enforced if orderly development of the sands was to take place.

### DEVELOPMENT LEASES

Because the provinces have owned mineral rights since 1930, the Alberta government is the body that grants leases to tar sands developers.

Leases are long-term agreements, covering 21 years. They are renewable for a second 21-year period and, if production is established, for even longer.

Companies leasing land from the Alberta government must pay a rental fee (currently 25 cents per acre). If the developer is successful in launching a commercial venture, a royalty fee is paid on the basis of production. Companies may also apply for prospecting permits for which a bonus is paid to the government.

To January 31, 1974, the Alberta government has realized approximately $33 million from these arrangements.

Since the oil companies began to seriously investigate the potential for oil sands development in the '50s, millions of acres have been leased. Most of the leases were granted in the late 1950s and virtually all major oil companies, as well as some smaller and independent firms, have taken out leases. In all, oil companies have leased 60 per cent of the Athabasca deposit, 24 per cent of the Cold Lake deposit and smaller areas of the Wabasca and Peace River sands.

*Over the years Fitzsimmons' Bitumont operation became capable of processing 500 tons of tar sand per day.*
Provincial Archives of Alberta

*Au courant des années l'opération Bitumont de Fitzsimmons devint capable de traiter 500 tonnes de sable bitumineux par jour.*
Archives Provinciales de l'Alberta

dans les sables bitumineux en 1913, lorsqu'on croit que l'utilisation la plus logique du matériel est celle du revêtement des routes. Il étudie la région à ce point de vue là et utilise le sable à cette fin avec succès. Sa contribution la plus importante au développement des sables, par contre, est son arpentage de la région. Ses bornes, cartes (incluant la topographie) et ses relevés d'altitudes ont été inappréciables pour les entrepreneurs qui l'ont suivi.

## R.C. FITZSIMMONS

R.C. Fitzsimmons continue à chercher la mare de pétrole "libre" en forant de la façon conventionnelle en 1923. En 1930, il réalise que ceci n'est pas pratique et que de nouvelles méthodes doivent être mises au point. Il met en marche une petite usine de séparation à Bitumount, où il mine les sables et sépare le bitume, utilisant un procédé à l'eau chaude.

Bien qu'il aggrandi et améliore son installation graduellement et obtient un certain succès en produisant le distillat et l'asphalte, des difficultés financières forcent Fitzsimmons à vendre sa compagnie en 1942. Le nouveau propriétaire est Oil Sands Ltd.

Malgré un prêt du gouvernement provincial et une aide technique, les successeurs de Fitzsimmons ont aussi des difficultés financières et en 1948, l'installation de Bitumount est reprise par le gouvernement de l'Alberta.

En 1949, l'usine sépare 500 tonnes de pétrole du sable par jour. L'opération Bitumount prouve qu'il est techniquement possible de séparer le pétrole du sable. La situation économique de l'opération requiert plus d'étude, toutefois, et puisque le gouvernement n'est pas intéressé à lancer une entreprise commerciale, l'usine est fermée.

Pendant ce temps, certains développements avaient lieu dans les sables. Depuis son établissement en 1919, le Conseil des recherches de l'Alberta étudiait la récupération des sables bitumineux dans son laboratoire à Edmonton et en chantiers, et, en 1929 il établit une petite usine pilote à Waterways près de Ft. McMurray. En collaboration avec le département des mines du gouvernement fédéral, le Conseil des recherches mine les sables et sépare le bitume utilisant la méthode de lavage à eau chaude. Le matériel de revêtement des routes obtenu de ces expériences est utilisé sur des rues d'Edmonton.

## ABASAND OILS LTD.

Vers ce temps-ci, Max Ball s'intéresse aux sables bitumineux et avec un groupe d'hommes d'affaires de Denver, ils tentent d'acheter l'usine-pilot du Conseil des recherches mais sont incapables de réunir les fonds nécessaires. Ball persiste toutefois, et en 1936 sa compagnie, Abasand Oils Ltd., est établie dans la vallée de la rivière Horse, au sud de McMurray. Utilisant un procédé modifié à l'eau chaude et une simple raffinerie, Ball réussit à produire un produit d'essence diesel qui est expédié par pipe-line et chaland vers des camps miniers sur le lac Athabasca.

En 1941, le Canada était en plein milieu d'une guerre et le gouvernement fédéral, de peur que les japonais entravent l'approvisionnement de combustibles pour l'ouest du Canada, commence à étudier de plus près, le développement des sables bitumineux. Un groupe d'observateurs est envoyé à l'usine Abasand afin de déterminer son progrès. Encouragé par cet intérêt, Ball cherche à améliorer son procédé et reçoit la permission de ses bailleurs de fonds de démolir et rebâtir son usine afin d'opérer plus efficacement.

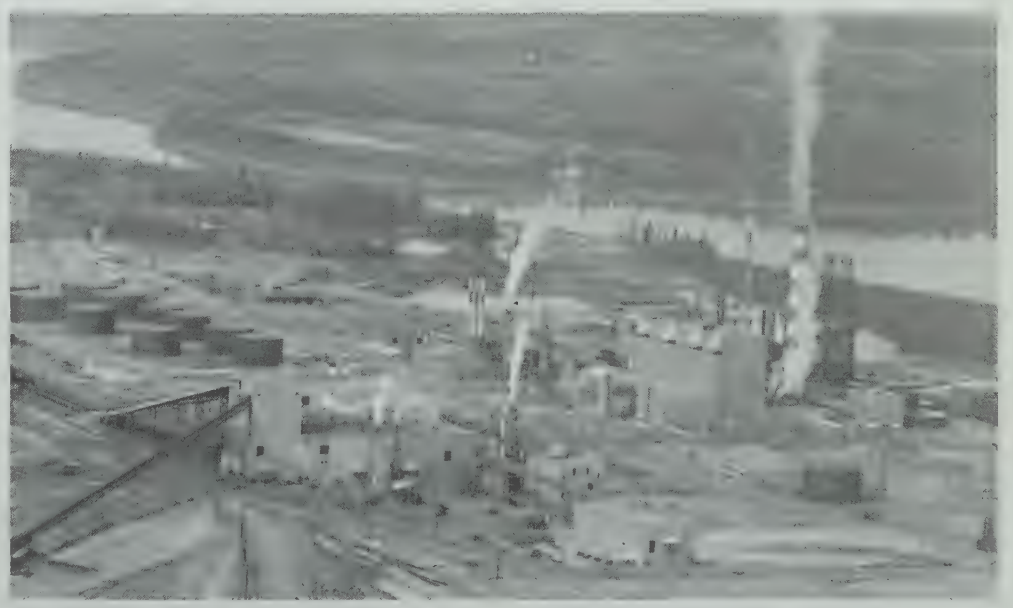
Avant que ceci soit accompli, toutefois, plusieurs changements ont lieu. L'état d'urgence du temps de guerre n'existe plus; Ball retourne aux Etats-Unis rappellé par le gouvernement; et le gouvernement canadien reprend Abasands. Bien que l'installation est rebâtie éventuellement, elle ne semble jamais opérer aussi bien que lorsque dirigée par Ball. En 1945, une étincelle jaillisant de la torche d'un soudeur met le feu à l'installation et elle brûle entièrement. L'installation n'est jamais reconstruite – et une autre ère de développement commercial prend fin.

## POSSIBILITE ECONOMIQUE

En 1950, les résultats d'une étude gouvernementale-industrielle (Le Rapport Blair) sur la possibilité économique de développer les sables bitumineux démontrent que, si une installation produisant 20,000 barils ou plus de brut synthétique par jour est construite, celle-ci, tout probablement, sera profitable.

L'industrie adopte alors une attitude plus positive envers le développement de grande envergure des sables bitumineux. L'une des premières compagnies pétrolières qui s'intéresse est Cities Service Co., qui forme une compagnie auxiliaire, Cities-Services Athabasca Inc., afin d'établir une usine-pilote de 1000 barils par jour à Mildred Lake, environ 25 milles au nord de Ft. McMurray. L'installation faisait des expériences minières, de manipulation du matériel et, de techniques d'extraction et à pleine capacité employait environ 150 personnes.

Pendant les premières années d'investigations des sables bitumineux, le gouvernement est indulgent envers les spéculateurs, mais c'a devient clair graduellement qu'il faudrait faire valoir un système de concessions et permis, afin que le développement méthodique des sables puisse être réalisé.



*The contemporary Great Canadian Oil Sands plant – the first modern plant to go into commercial synthetic crude oil production in the Athabasca Tar Sands.*

*L'installation contemporaine de Great Canadian Oil Sands – la première installation moderne à se lancer dans la production de pétrole brut synthétique dans les Sables Bitumineux de l'Athabasca.*

The remaining land is held by the Crown (in this case, the province of Alberta), the federal government, companies and individuals.

## GREAT CANADIAN OIL SANDS

Because of the staggering costs involved in building a tar sands plant large enough to be efficient, few companies have yet committed themselves in this regard. However, all have watched with keen interest the experience of the Great Canadian Oil Sands Ltd. plant. As the pioneer in the field of large-scale commercial development of the sands, the GCOS plant has had to contend with the myriad problems involved in working with new and complicated procedures and equipment. Although not yet considered an economic success, the operation is proving invaluable as a model for future developments.

Now, a second plant is taking shape in the tar sands near Mildred Lake. Construction of the $2 billion Syncrude Canada Ltd. plant began in 1974, and commercial production is expected to start in 1978. The project represents a unique government-industry joint venture. Involved in the complex which will produce 125,000 barrels of synthetic crude oil a day, are Imperial Oil Limited, Canada-Cities Service Limited, Gulf Oil Canada Limited and the governments of Canada, Alberta and Ontario.

Syncrude plans to use four mammoth draglines to mine the sands. Some idea of their size can be gained from the fact that in one year their 80 cubic yard buckets will mine 92 million tons of sand, approximately five times the total amount of coal and twice the iron ore mined in Canada in 1970.

This plant will also use a hot-water method of extraction, but the process differs slightly from that used by GCOS.

The third proposal to receive approval from the Alberta Energy Resources Conservation Board, is one put forth by Shell Canada Ltd. Again the process involves mining and hot-water extraction. This plant would be slightly smaller than the Syncrude development. Also approved by the ERCB is a proposal by a group of oil companies, headed by Petrofina Canada Ltd., and a fifth plant, still under study, has been proposed by Home Oil Co. Ltd.

To date, no one has announced plans to establish an in-situ operation on a commercial scale, although much research into this approach has been done by Shell Oil (in the Peace River deposit) and Imperial Oil (at Cold Lake). However, industry spokesmen believe such a plant could well be a reality by the mid-1980s.

## CONCESSIONS DE DEVELOPPEMENT

Parce que les provinces possèdent les droits minéraux depuis 1930, le gouvernement de l'Alberta est l'organisme qui accorde les concessions aux entrepreneurs qui développent les sables bitumineux.

Les concessions sont à long-terme, soit 21 ans. Elles sont renouvelables pour une deuxième période de 21 ans et pour plus longtemps encore, si on institue la production.

Les compagnies louant le terrain à concession du gouvernement albertain doivent payer un loyer (présentement 25c l'acre). Si l'entrepreneur réussit à lancer une entreprise commerciale, un taux de royalty est payé, basé sur le rendement. Les compagnies peuvent demander des permis de prospection pour lesquels une prime est payée au gouvernement.

Jusqu'au 31 janvier, 1974, le gouvernement de l'Alberta a réalisé environ $33 millions de ces arrangements.

Depuis que les compagnies pétrolières dans les années 50 ont commencé à examiner sérieusement le potentiel du développement des sables oléagineux, des millions d'acres ont été loués. La plupart des concessions ont été accordées vers la fin des années 50 et presque toutes les compagnies pétrolières importantes, ainsi que quelques firmes, petites et indépendantes, ont obtenu des concessions. En tout, les compagnies pétrolières ont loué 60% du gisement de l'Athabasca, 24% du gisement de Cold Lake et des plus petits dans les sables de Wabasca et de Peace River.

La couronne (dans ce cas-ci, la province de l'Alberta), le gouvernement fédéral, les compagnies et certains individus occupent le terrain qui reste.

## GREAT CANADIAN OIL SANDS

A cause des coûts renversants lorsqu'ils s'agit de construire une installation de sables bitumineux assez large pour être efficace, peu de compagnies, à venir jusqu'à maintenant, se sont engagées. Toutefois, toutes ont observé avec grand intérêt l'expérience de l'installation de Great Canadian Oil Sands Ltd.

En tant que pionnier du cercle intéressé à développer les sables complètement, l'installation GCOS a du faire face à une myriade de problèmes qui s'ensuivent lorsqu'on doit travailler avec un outillage et des procédés nouveaux et compliqués. Quoique pas encore considérée un succès économique, l'opération s'avère inappréciable comme modèle pour les développements futurs.

Maintenant, une seconde installation prend forme dans les sables bitumineux à Mildred Lake. La construction de l'usine de $2 milliards de Syncrude Canada Ltd. a commencé en 1974 et on compte commencer la production commerciale au début de 1978. Le projet représente une co-entreprise gouvernementale-industrielle unique. Engagés dans le complexe qui produira 125,000 barils de pétrole brut synthétique par jour, sont: - Imperial Oil Limited, Canada-Cities Service Limited, Gulf Oil Canada Limited et les gouvernements du Canada, de l'Alberta et de l'Ontario.

Syncrude projette utiliser quatre immenses dragueurs à godets. On peut obtenir une impression de leur largeur lorsqu'on sait que pendant une année, leurs godets de 80 verges cubiques minent 92 millions de tonnes de sable, approximativement cinq fois plus que le montant total de charbon et deux fois le montant de minerai de fer miné au Canada en 1970.

Cette installation utilisera aussi la méthode d'extraction à l'eau chaude, mais le procédé, diffère légèrement de celui de GCOS.

La troisième proposition qui reçoit l'approbation du Conseil de la conservation des ressources énergétiques de l'Alberta, est soumise par Shell Canada Ltd. Encore une fois, le procédé entraîne la nécessité de miner et une extraction à l'eau chaude.

Cette installation sera légèrement moins grande que le développement Syncrude. Le CCREA a approuvé aussi une proposition soumise par un groupe de compagnies pétrolières ayant à sa tête la compagnie Petrofina Canada Ltd. et une cinquième usine, que l'on est à étudier actuellement, a été proposée par Home Oil Co. Ltd.

Jusqu'à maintenant, personne n'a annoncé de projets concernant l'établissement d'une opération in-situ sur une base commerciale, quoique beaucoup de recherches ont été effectuées sur cette manière d'aborder le problème par Shell Oil (dans le gisement de Peace River) et par Imperial Oil (à Cold Lake). Cependant, les porte-paroles de l'industrie croient qu'il se pourrait qu'une telle installation soit réalisée d'ici le milieu des années 1980.

# THE POTENTIAL OF THE TAR SANDS

*by Lois Bridges*

Because oil is a non-renewable resource, energy experts are keeping a close watch on remaining world supplies. Predicting how much oil, from any source, will be available by the end of this century, is obviously extremely difficult. There's always the possibility some reserves will prove larger than expected – or totally new discoveries may be made. Also, some reserves could change from the "potential" to the "proved" category.

Such possibilities are kept in mind but, generally, experts agree most major likely sources of conventional and synthetic crude oil have been identified and realistic estimates have been made of when they might be developed.

At the moment in Canada, the rate at which conventional crude oil can be supplied and the rate at which it is being used are pretty well in balance, but this will not always be the case. Conventional crude supplies are already beginning to show signs of dwindling.

How much conventional oil do we have left and where is it? As the accompanying chart shows, approximately 1,200 billion barrels include all reserves we know can be tapped as well as those which may ultimately be available to us. More than half the world's known recoverable conventional reserves of 635 billion barrels are in the Middle East. The Soviet Bloc and China have about one-sixth of total reserves, Africa has about one-fifth and North America has less than one-twelfth of the total. In Canada, reserves of conventional crude were 8.5 billion barrels at the end of 1973.

In 1972, Canadian demand was 1.6 million barrels per day. By 1990, it's estimated that requirements will have doubled to more than 3.2 million barrels a day. It's almost certain that our conventional production won't be able to keep up. In Alberta, which accounts for about 90 per cent of Canada's conventional production, it's expected conventional reserves could drop to half the 1972 total by 1985.

### ATTENTION ON TAR SANDS

This is one reason government and industry are now focusing attention on development of the tar sands. Although

# LE POTENTIEL DES SABLES BITUMINEUX

*par Lois Bridges*

Parce que le pétrole est une ressource non-renouvelable, les experts en énergie surveillent de très près les approvisionnements qui restent au monde. C'est évidemment extrêmement difficile de prédire quelle quantité de pétrole, de quelque source que ce soit, sera disponible d'ici la fin du siècle. Il est toujours possible que certaines réserves s'avèreront plus larges que prévu – ou il y aura peut-être des découvertes totalement nouvelles.

Aussi, certaines réserves pourraient se trouver dans le catégorie "prouvée" plutôt que "potentielle".

On doit considérer ces possibilités, mais, en général, les experts sont d'accord que la plupart des sources probables importantes de pétrole brut conventionnel et synthétique ont été identifiées et des évaluations réalistes ont été faites en ce qui a trait au temps où elles seront probablement développées.

Au Canada en ce moment, la proportion dont le pétrole brut conventionnel peut être fourni et la proportion dont on l'utilise est à peu près la même. Mais ceci ne sera pas toujours le cas. Les approvisionnements de brut synthétique semblent déjà commencer à diminuer.

Quelle quantité de pétrole conventionnel avons-nous est où est-il? Tel que le tableau ci-joint l'indique, environ 1,200 milliards de barils incluent toutes les réserves que nous savons exploitables, ainsi que celles qui pourraient finalement être à notre disposition. Plus de la moitié des réserves conventionnelles récupérables au monde, s'élevant à 635 milliards de barils, sont au Moyen-Orient. Le Bloc Russe et la Chine ont environ 1/6 des réserves totales, l'Afrique a à peu près 1/5 et l'Amérique du Nord moins d'un douzième (1/12) du total. Au Canada, les réserves de brut conventionnel étaient 8.5 milliards de barils à la fin de 1973.

En 1972, la consommation canadienne était 1.6 milliards de barils par jour. D'ici 1990, on juge que les exigences auront doublées à plus de 3.2 milliards de barils par jour. C'est presque certain que notre production conventionnelle ne pourra pas suffire. En Alberta, qui rend près de 90% de la production au Canada, on juge que les réserves conventionnelles pourraient diminuer de moitié du total de 1972 d'ici 1985.

the potential of the sands has long been recognized, it is only recently that the conventional oil supply-demand situation has made it economically feasible to attack the enormously expensive job of development.

In addition, rising prices for oil, recently demanded by the Middle East's Organization of Petroleum Exporting Countries (OPEC) have helped convince Canada of the importance of becoming as nearly self-sufficient as possible in oil supply.

The tar sands area of northern Alberta covers some 19,000 square miles and contains ultimate reserves of more than 900 billion barrels of oil in four major deposits. From the Athabasca Tar Sands alone (the world's largest known deposit), 26.5 billion barrels of synthetic crude can be produced by present methods from proved, mineable oil sands. Scientists at the Alberta Research Council say this would be enought to meet Canada's anticipated total needs for at least 25 years. Future improvements in mining and processing techniques may raise this figure to over 80 billion barrels.

Although Alberta's Energy Resources Conservation Board anticipated in 1972 that at least one 100,000-barrel-per-day oil sands plant would be built in tar sands every two years throughout the 1980s and 1990s, this projection has had to be altered, largely because inflation has served to skyrocket the costs involved.

Several oil firms have stated their intention of building plants in future and some have established pilot plant operations. At the moment, however, the Great Canadian Oil Sands plant, in production since 1967, and the Syncrude Canada Ltd., plant, now under construction, are the only major commercial developments.

## IN SITU PROCESS

But what about the oil-bearing sands that lie too far beneath the earth to be reached by surface mining? It's expected that by 1980s, research into *in-situ* (in-place) recovery could provide a means of tapping this resource too. When this becomes a reality, estimates are that an additional 250 billion barrels would be recoverable.

Research into schemes that would not only separate the oil from the sand, but also thin it for recovery by conventional methods, has been going on for many years. Virtually every major oil company holds leases in the tar sands and many are actively researching methods of developing their holdings.

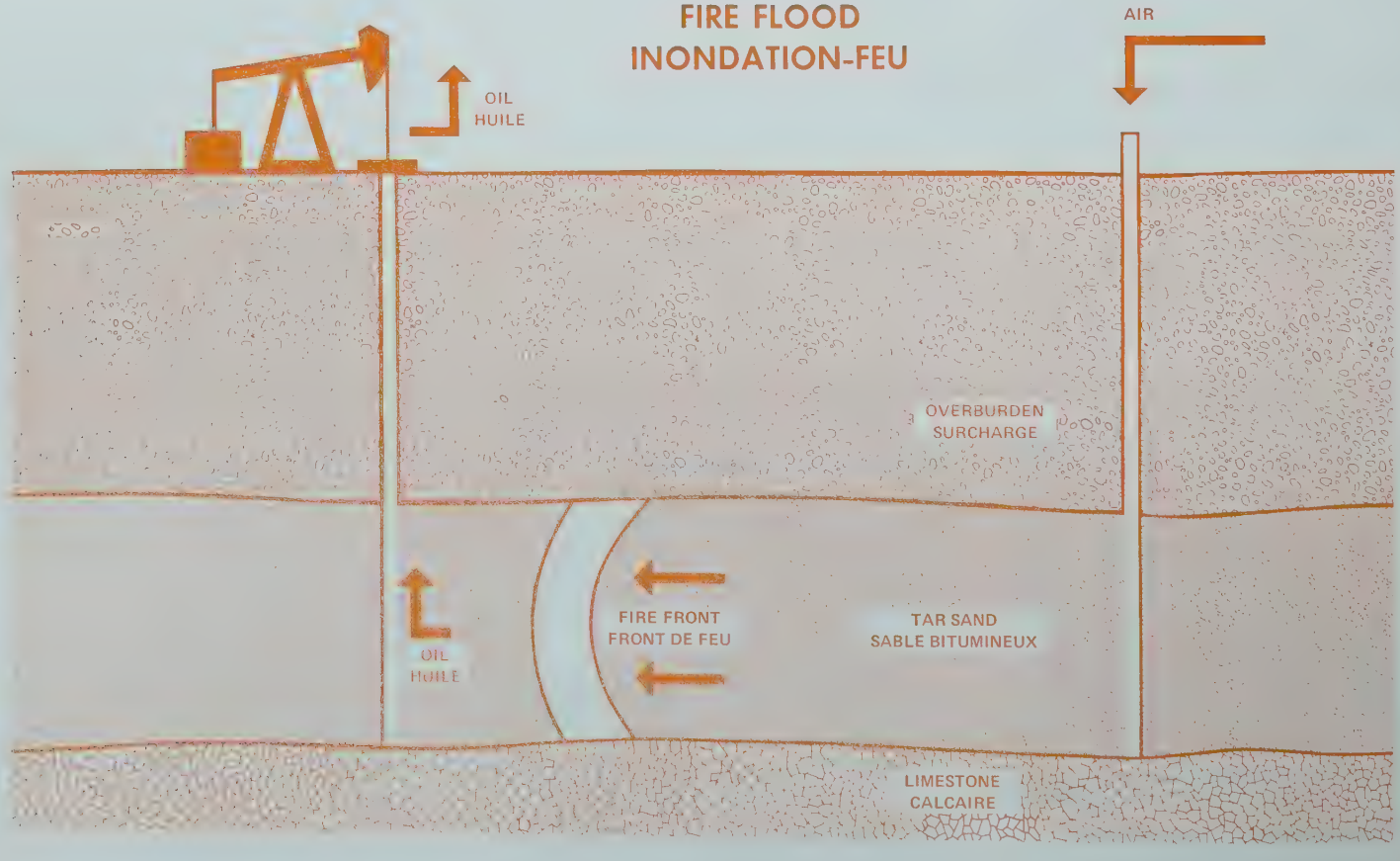
Efforts to develop *in-situ* techniques have already been moderately successful. Today, at Cold Lake, Alberta's second largest deposit, Imperial Oil has established pilot plants to recover oil by steam injection (sometimes called "huff and puff").

Steam is heated to 600 deg. F., then pumped directly into the deposit at pressures up to 2,000 pounds per square inch. ("huff") Not only does the heat thin the heavy oil, but the pressure later helps to pump the oil to the surface. Steam injection continues for about a month. Then for approximately three months the process is reversed; the injection well becomes a producing well as a mixture of warm oil, water and gas is pumped to the surface. ("puff") Once the amount of oil in the water reaches a low level, the steam injection cycle begins again. The operation is currently producing 5,000 barrels of heavy oil per day which is transported to a refinery in specially insulated trucks that keep the oil at 180 deg. F.

Despite encouraging results from pilot projects, the company doesn't feel its steam injection technique is economically sound enough to warrant a full scale *in-situ* development at this time. They estimate such a plant would cost about the same as the mining and extraction facility currently being built in the Athabasca sands.

## PEACE RIVER PILOT

Plans by another oil company, Shell Canada Ltd., to establish a large scale pilot plant to test *in-situ* techniques in the Peace River deposit have been temporarily postponed. To date, there is no



## L'ATTENTION ATTIREE VERS LES SABLES BITUMINEUX

C'est une des raisons pourquoi le gouvernement et l'industrie se concentrent maintenant sur le développement des sables bitumineux. Quoique qu'il y a longtemps que le potentiel des sables est reconnu, c'est seulement récemment que la situation approvisionnement-consommation a rendu économiquement possible d'attaquer le travail de développement qui est énormément onéreux.

De même, l'augmentation des prix du pétrole, demandé dernièrement par l'Organisation des pays exportateurs de pétrole (OPEP) du Moyen-Orient, a réussi à convaincre le Canada qu'il est important de devenir aussi indépendants que possible concernant l'approvisionnement de pétrole.

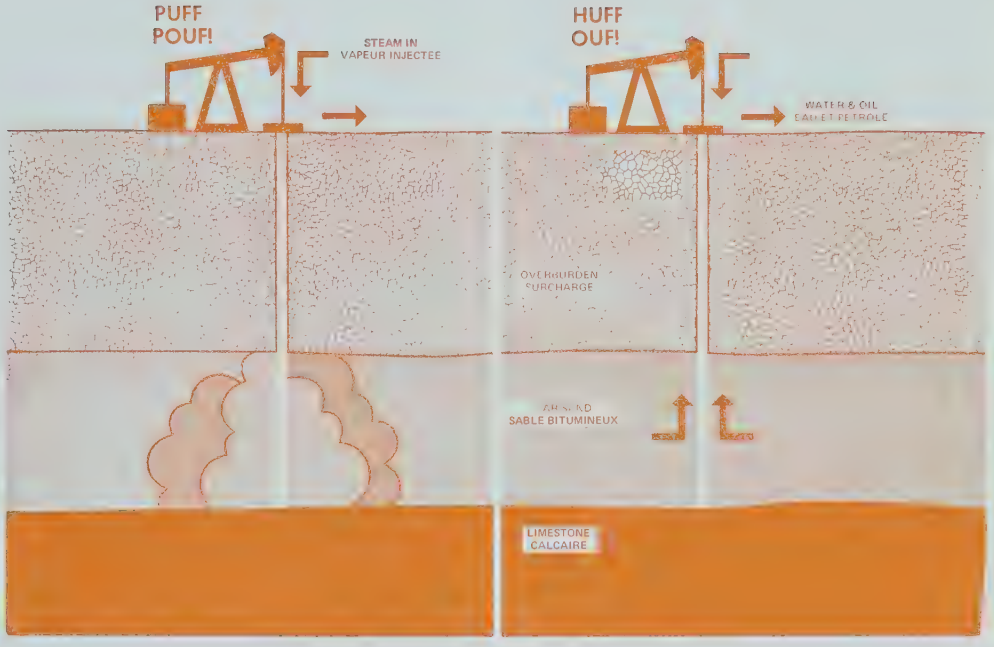
La région des sables bitumineux du nord de l'Alberta couvre quelque 19,000 milles carrés et contient des réserves ultimes de plus de 900 milliards de barils de pétrole dans quatre gisements importants. Simplement des sables bitumineux de l'Athabasca (le gisement reconnu le plus large au monde), 26.5 milliards de barils de brut synthétique peuvent être extraits des sables oléagineux prouvés, en se servant des méthodes courantes.

Les scientifiques au Conseil des recherches de l'Alberta envisageaient en 1972 qu'au moins une usine de sables oléagineux recélant 100,000 barils par jour serait construite dans les sables bitumineux à tous les deux ans durant les années 1980 et 1990. On a du changer cette prévision, surtout parce que l'inflation à fait monter en flèche les coûts.

Plusieurs firmes pétrolières ont fait part de leur intention de construire des installations à l'avenir et quelques-unes ont commencé à opérer dans des usines-pilotes. En ce moment, toutefois, l'installation de Great Canadian Oil Sands, en production depuis 1967, et l'usine présentement en construction de Syncrude Canada Ltd. sont les seuls développements commerciaux d'importance majeure.

## PROCEDE IN-SITU

Mais, que fait-on des sables oléagineux qui reposent trop profondément sous la terre pour être rejoints par une mine de surface? On envisage que d'ici les 1980, les recherches touchant à la récupération in-situ (en place) pourraient fournir un moyen de prendre avantage de cette ressource aussi. Lorsque ceci aura lieu, on prévoit que 250 milliards de barils additionnels seront récupérables.




Les recherches dans les systèmes qui non seulement sépareraient le pétrole du sable, mais aussi le rafinerait aux fins de récupération, par des méthodes conventionnelles, durent depuis des années. Presque chaque compagnie pétrolière importante a des concessions dans les sables bitumineux et, plusieurs parmi celles-ci, recherchent activement des méthodes de développement pour les mettre en valeur.

Les efforts de développement de techniques in-situ ont été courronnés de succès modestes. Aujourd'hui à Cold Lake, deuxième plus important gisement en Alberta, la compagnie Imperial Oil a établi des usines-pilotes pour récupérer le pétrole par injection de vapeur.

La vapeur est chauffée jusqu'à 600°F, ensuite pompée directement dans le gisement, sous pressions qui vont jusqu'à 2,000 livres par pouce carré. Non seulement la chaleur raffine le pétrole lourd, mais encore la pression, plus tard, aide à pomper le pétrole à la surface. L'injection de vapeur continue pour environ un mois. Ensuite, pour à peu près trois mois, le procédé est renversé; le puits pompé devient puits éruptif lorsqu'un mélange de pétrole chaud, d'eau et de gaz est pompé à la surface. Lorsque la quantité de pétrole dans l'eau baisse, le cycle d'injection de vapeur recommence. L'operation produit actuellement 5,000 barils de pétrole lourd par jour qui est transporté à une raffinerie dans des camions spécialement isolés qui maintiennent le pétrole à 180°F.

Malgré des résultats encourageants obtenus dans des usines-pilotes, la compagnie estime que sa technique d'injection de vapeur n'est pas suffisamment rentable pour permettre en ce moment, un développement in-situ de grande envergure. Ils estiment qu'une telle usine coûterait environ le même prix que l'installation minière et d'extraction que l'on construit dans les sables de l'Athabasca.

## PROJET-PILOTE DE PEACE RIVER

Shell Canada Ltd., une autre compagnie pétrolière, projettait établir une usine-pilote importante pour éprouver les techniques in-situ dans le gisement de Peace River, mais ceci a été remis temporairement. Jusqu'à date, il n'y a aucune installation in-situ d'envergure commerciale.

Pendant des années, on a essayé une variété de méthodes de récupération thermique afin de déloger l'épais bitume goudronneux des sables qui l'enserrent. Une de ces techniques s'appelle inondation-feu. La chaleur est employée en mettant le feu au pétrole dans les plis et en le conservant dans un état de combustion partiel ou total. Les températures élevées rendent le pétrole moins visceux et plus facile à déplacer.

commerical-scale, *in-situ* plant in operation.

Over the years a variety of thermal recovery methods have been tried in an effort to dislodge the thick, tar-like bitumen from the sands that surround it. One such technique is called fire flooding. The heat is applied by actually igniting oil in the formation and keeping it in a state of total or partial combustion. The high temperatures make the oil less viscous and easier to move.

Experiments in *in-situ* combustion are currently being carried out by the U.S. government in the tar sands of Utah. The technique involves drilling a cluster of wells in the sands formation. The central wells are ignited and air is injected into the outside wells in order to heat bitumen in the formation to the vapor stage. It can then be brought to the surface, cooled, and the oil condensed out. Although all the bitumen in a tar sands deposit cannot be recovered using this method, researchers hope to prove that 50% recovery can be accomplished.

## NUCLEAR DEVICE

An even more dramatic way of recovering oil from tar sands was suggested in 1958. A proposal was put forth by a group of oil firms, headed by Richfield Oil Company, to use a nine-kiloton nuclear device to be supplied by the U.S. Atomic Energy Commission.

It was believed the device, which was to have been exploded at a depth of 1250 feet, would creat a cavity of 340 feet in diameter. Developers of the scheme said this cavity would contain, as useful thermal energy, up to half the energy of the blast. Once the bitumen was heated and became mobile, they said, it could be produced in a conventional manner.

Although Project Oil Sands, as the proposal was called, received technical study, the Canadian government deferred action on the plan and it was eventually dropped. However, it's interesting to note that natural gas has since been recovered in Nevada by means of a nuclear explosion.

Not all schemes for tackling recovery of oil from tar sands are as grandiose as Project Oil Sands, but the immensity of the resource and the challenge of its recovery continue to fire the imagination of government, university and industry researchers.

## A.O.S.T.R.A.

To help support their oil sands experiments, the Alberta government established the Alberta Oil Sands Technology and Research Authority in July, 1975. AOSTRA is responsible for administering $100 million in grants to encourage both short and long-term oil sands research. In addition, dozens of research projects have been independently launched by industry and universities in Canada.

The scientists involved doubt there is a single "magic answer" to the problems of oil sands recovery. What they hope to do is accomplish a series of technical "breakthroughs" that will eventually make the production of synthetic crude as straightforward a process as production of conventional crude has become in the past several decades.

| | Recoverable conventional reserves | Recoverable synthetic reserves | Potential recoverable synthetic reserves |
|---|---|---|---|
| | | (billion barrels) | |
| **North America** | | | |
| Established areas | 51 | | |
| Alberta Tar Sands | | 26.5 | 250 |
| Oil Shales | | N/A | 80 |
| **Central & South America** | | | |
| Established areas | 32 | | |
| Orinoco heavy oil belt | | | 200 |
| **Western Europe** | 16 | | |
| **Middle East** | 350 | | |
| **Africa** | 67 | | |
| **Asia – Pacific Rim** | 16 | | |
| **Soviet Bloc & China** | 103 | | |
| **TOTAL** | 635 | 26.5 | 530 |

Le gouvernement des Etats-Unis fait actuellement des expériences de combustion in-situ dans les sables du Utah. La technique entraîne le forage d'un groupe de puits dans les plis des sables. Les puits du centre sont allumés et de l'air est injecté dans les puits extérieurs afin de chauffer le bitume dans les plis, jusqu'à ce qu'il soit en état de vapeur. Il peut ensuite être amené à la surface, refroidi et le pétrole ensuite condensé. Quoique tout le bitume des gisements de sables bitumineux ne peut pas être récupéré utilisant cette méthode, les chercheurs espèrent prouver qu'une récupération de 50% est possible.

## APPAREIL NUCLEAIRE

On a suggéré en 1958 une façon encore plus dramatique de récupérer le pétrole des sables bitumineux. Un groupe de compagnies pérolières ayant à sa tête la compagnie Richfield Oil a proposé d'utiliser un appareil nucléaire de 9 kilotonnes fourni par la Commission d'énergie atomique des Etats-Unis.

On croyait que l'appareil, qui devait être explosé à une profondeur de 1250 pieds créerait une excavation de 340 pieds de diamètre. Les personnes ayant développé le système disent que cette cavité contiendrait, en tant qu'énergie thermique utile, presque la moitié de l'énergie de l'explosion. Une fois que le bitume est chauffé et devient mobile, disent-ils, il peut être produit de la façon conventionnelle.

Bien que le Projet-sables-oléagineux comme il était appellé a fait l'objet d'études techniques, le gouvernement canadien a remis à plus tard le plan d'action et il a éventuellement été cancellé. Cependant, il est important de noter qu'on a récupéré du gaz naturel au Nevada depuis, au moyen d'une explosion nucléaire.

Pas tous les projets tentant de récupérer le pétrole des sables bitumineux sont aussi grandioses que le Projet des sables oléagineux mais l'immensité de la ressource et le défi que sa récupération présente continuent d'intriguer les gouvernements, universités et chercheurs dans l'industrie.

| | Réserves conventionnelles récupérables | Réserves de synthétiques récupérables | Réserves potentielles de synthétiques récupérables |
|---|---|---|---|
| | | (milliards de barils) | |
| **Amérique du Nord** | | | |
| Régions établies | 51 | | |
| Sables bitumineux de l'Alberta | | 26.5 | 250 |
| Schistes huileux | | S/O | 80 |
| **Amérique Central et du Sud** | | | |
| Régions établies | 32 | | |
| Ceinture de pétrole lourd d'Orinoco | | | 200 |
| **Europe Occidentale** | 16 | | |
| **Moyen-Orient** | 350 | | |
| **Afrique** | 67 | | |
| **Asie-Côte du Pacifique** | 16 | | |
| **Bloc soviétique & Chine** | 103 | | |
| **TOTAL** | 635 | 26.5 | 530 |

## L'A.R.T.S.O.A.

Afin d'appuyer leurs expériences dans les sables bitumineux, le gouvernement de l'Alberta a établi l'Autorité des recherches et de la technologie des sables oléagineux de l'Alberta en juillet, 1975. L'ARTSOA est responsable de l'administration de $100 millions en octrois qui ont pour but d'encourager les recherches à long et court-terme dans les sables oléagineux. De plus, des douzaines de projets de recherches ont été lançés indépendamment par l'industrie et les universités au Canada.

Les scientifiques concernés doutent qu'il existe une simple "solution magique" aux problèmes de récupération dans les sables oléagineux. Ce qu'ils espèrent c'est d'accomplir une série de découvertes techniques qui, éventuellement, feront de la production du pétrole brut synthétique, un procédé aussi simple que l'est devenu, depuis quelques décennies, celui de la production du brut conventionnel.

# With respect for the environment

*by Peter Lee*

As the extent and diversity of human demands upon the natural environment and its resources continue to mount, increasing concern is being expressed over the ability of the environment to tolerate these demands.

That the development of the tar sands will create significant environmental disturbances has been recognized by government and industry alike. The control of the extent of this impact is being accepted as a mutual responsibility of both the public and private sectors.

Federal and provincial governments insititute laws and regulations to ensure the control of major environmental aspects of tar sand developments. Developers are bound to comply with the statutes established, such as the Federal Migratory Birds Protection Act and the Navigable Waters Protection Act, the Alberta Clean Air and Clean Water Acts and the Land Surface Conservation and Reclamation Act. As well, the Alberta Department of the Environment has prescribed a procedure for assessing environmental impact. It is at their direction that statements are issued for each of the planning, construction and operational phases of major resource development.

The Alberta government has also instituted a $40 million, 10-year environmental research program to deal mainly with problems affecting the entire tar sands region. Problems specific to the construction and operation of tar sand plants are the concern of the developing companies.

*Research into atmospheric conditions in the tar sands area is an important continuing program. Les recherches touchant aux conditions atmosphériques dans la région des sables bitumineux est un programme qui continue à être important.*

The first company to begin development of a producing tar sands plant within the guidelines of today's environmental regulations is Syncrude Canada Ltd., now in the construction phase of a $2 billion project. In addition to the responsibilities assigned to the company by government regulations, Syncrude early established its own environmental objectives and policies. Their environmental policy statements begins: "Syncrude Canada Ltd. works with the conviction that human use of the environment need not be destructive. With careful planning, based upon good information, man-altered and natural ecosystems can exist in harmony."

## ENVIRONMENT TEAM

Three years before the start of construction of the project, a team of environmental personnel was built up within the company to provide professional, top level input into company decisions. The team has included experienced biologists (botanists, zoologists,

# Respect pour l'environnement

*par Peter Lee*

Etant donné que la mesure et la diversité des exigences humaines vis-à-vis l'environnement naturel et ses ressources continuent à augmenter, on exprime une inquiétude croissante en ce qui a trait à l'habileté de l'environnement à tolérer ces exigences.

Les gouvernements et l'industrie ont de même reconnu que le développement des sables bitumineux créerait une perturbation importante de l'environnement. Le contrôle de la mesure de cet impact est accepté en tant que responsabilité mutuelle, de part de d'autre par le secteur public et le secteur privé.

Les gouvernements fédéral et provinciaux passent des lois et règlements pour assurer le contrôle d'aspects majeurs de l'environnement concernant les développements des sables bitumineux. Les entrepreneurs sont tenus d'obéir aux lois établies, telles la Loi fédérale de la Protection des Oiseaux Migrateurs et la Loi de la Protection des Eaux Naviguables, la Loi de l'Air Pur et la Loi de l'Eau Pure et la Loi de la Réclamation et Conservation de la Surface de la Terre de l'Alberta. Aussi, le département de l'Environnement de l'Alberta a prescrit un procédé pour déterminer l'impact sur l'environnement. C'est sous leur direction que des déclarations sont faites pour chacune des phases de projection, de construction et opérationnelle d'un développement majeur de ressource.

Le gouvernement de l'Alberta a aussi institué un programme de recherches sur l'environnement de $40 millions et d'une durée de dix ans pour résoudre principalement les problèmes touchant la région entière des sables bitumineux. Les problèmes propres à la construction et l'opération des installations des sables bitumineux concernent strictement les compagnies de développement.

La première compagnie à développer une installation productrice dans les sables bitumineux, à l'intérieur des lignes de conduite que l'on trouve dans les règlements actuels sur l'environnement, est Syncrude Canada Ltd., présentement en période de construction pour un projet de 2 billions de dollars. En plus des responsabilités assignées par les règlements du gouvernement à la compagnie, Syncrude a établi, très tôt, ses propres buts et politiques sur l'environnement. Leur déclaration de politique sur l'environnement débute comme suit: "Syncrude Canada Ltd. oeuvre avec la conviction

ecologists), geographers, chemists and environmental engineers and technicians.

To widen the perspective from which the complex problems involved are viewed, outside consultants are contracted to research the technical aspects of many specific problems. Soil scientists at the University of Alberta are working in cooperation with the Alberta Department of Agriculture on soil and vegetation studies. Private consulting firms, in Alberta and across Canada are under contract to conduct ornithological, aquatic biological, entomological and climatological research. A number of individuals are carrying out investigations in the areas of archaeology, hydrology and lichenology.

Syncrude's programs for environmental control have four major objectives: to determine the conditions prevailing in the area before any disturbance occurred; to monitor the effects of construction and operation of the plant on the environment; to plan and conduct the research which will ensure successful reclamation and revegetation of the site; and to be constantly aware of, and able to respond to, any possible changes which were not anticipated.

## BASELINE STUDIES

To accomplish the first phase of the objectives, preliminary baseline investigations have been conducted over the past several years. These are concentrated in those areas where information was vital to rational environmental decisions. Some resulted in an accumulation of valuable new data, some identified areas where further research is required, and others indicated necessary changes in construction or operational activities.

Baseline date collection occupied nearly 100 per cent of the environmental resources of the company for the first few years. Then, with the beginning of construction, the emphasis shifted to the second objective. Monitoring activities and the initiation of specific research programs became paramount.

Environmental monitoring programs and impact assessment related to the long-term disposal of saline water from the mine area have been initiated. A mobile air-quality monitoring station obtains baseline data for sulphur dioxide and hydrogen sulphide concentrations as well as wind speed and direction. A meteorological station is operated in conjunction with the Canadian Atmospheric Environment Service to obtain data which is forwarded to the government for public and private use. Syncrude uses this data for determining various construction parameters.

Water flow systems from an area of 32,400 hectares (125 square miles) will be disrupted. Studies have been conducted for several years to predict, describe and modify the effects of tar sand development on these aquatic systems. Groundwater flows in the McMurray area present several potential environmental problems. These are regional in nature and cannot be adequately defined or solved by studies on individual leases, so a number of industry and government bodies are cooperating in hydrogeological studies of the area.

*Much of the Athabasca Tar Sands area is covered with muskeg, a soggy mixture of moss and other vegetation, saturated with water, which is virtually impassable except when frozen . . .*

*Une grande partie de la région des sables bitumineux de l'Athabasca est recouverte de muskeg, un mélange saturé de mouse et autre végétation, saturé d'eau, qui est effectivement impassable sauf lorsque gelé . . .*

## MAXIMUM DISPERSION

The operation of a synthetic crude oil plant results in the production of large volumes of sulphur dioxide, carbon dioxide, nitrogen oxides and water vapour. It is important that the plant is designed to reduce the emission levels and to encourage the maximum dispersion of these gases when they reach the atmosphere. Because climatology is regional in nature, a number of leaseholders in the tar sands are conducting a program to measure atmospheric conditions that control gaseous dispersion in the McMurray area.

Syncrude maintains an onsite environmental laboratory in the McMurray area to provide immediate chemical and physical baseline information; to monitor environmental impact of construction activities and to provide assistance to the numerous consulting groups and individuals in the field.

## BIRD HABITAT

A wide variety of birds utilize the Ford McMurray region of the tar sands for migration stopovers, breeding, nesting and moulting. Development of the area could eliminate favourable habitat, both aquatic and terrestrial, and establish unfavourable habitats, particularly aquatic, that could prove to be attractive and hazardous. The most serious problem which could be created is possible oiling of birds landing on a "tailings pond", the area into which effluents from the process will be discharged. This body of water could remain open when others are frozen over and might therefore attract waterfowl.

In recognition of the potential hazards of the tailings pond, Syncrude is conducting research into three separate aspects of the problem: to improve the efficiency of the separation process, thereby decreasing the amount of bitumen discharged to the tailings pond; to improve methods to contain within a small area of the pond any bitumen which is discharged; and to develop deterrents which will prevent

que l'utilisation humaine de l'environnement n'est pas nécessairement destructrice. Avec une projection prudente, baséè sur de bonnes informations, des systèmes écologiques "changés par l'homme" ou naturels peuvent exister en harmonie.

## EQUIPE-ENVIRONNEMENT

Trois ans avant le début de la construction du projet, une équipe de personnel spécialisée en environnement a été formée à l'intérieur de la compagnie pour fournir la possibilité qu'elle puisse conseiller professionnellement ainsi qu'au plus haut palier de la compagnie, lorsqu'il s'agit de décisions prises par cette compagnie. L'équipe se composait de biologistes d'expérience (botanistes, zoologistes, écologistes), de géographes, chimistes et d'ingénieurs et techniciens en environnement.

Pour permettre une plus grande perspective afin d'observer les problèmes complexes impliqués, on donne des contrats à des conseillers de l'extérieur pour faire des recherches sur les aspects techniques de plusieurs problèmes spécifiques. Des scientifiques, spécialistes du sol, à l'Université de l'Alberta oeuvrent en coopération avec le département de l'Agriculture de l'Alberta à des études portant sur le sol et la végétation. Des firmes privées de conseillers en Alberta et à travers le Canada, sont sous contrat afin d'exécuter des recherches en ornithologie, biologie aquatique, entomologie et climatologie. Un certain nombre d'individus poursuivent des investigations dans les secteurs d'archéologie, hydrologie et "lichenologie".

Les programmes de Syncrude pour le contrôle sur l'environnement ont quatre buts principaux: déterminer les conditions qui existent dans la région avant qu'aucune perturbation ait lieu; contrôler les effets de la construction et l'opération de l'usine sur l'environnement; projeter et exécuter les recherches qui assureront la réussite d'une réclamation et revégétation du site; et être constamment conscients et capables de réagir à des changements possibles qui n'avaient pas été envisagés.

## ETUDES DE BASE

Afin de rencontrer la première étape des buts, des investigations de base préliminaires ont été faites depuis plusieurs années. Celles-ci se sont concentrées sur les secteurs où les données étaient essentielles afin de prendre des décisions logiques touchant l'environnement. Quelques-unes ont eu pour résultat l'accumulation de données inestimables, d'autres ont identifié les secteurs où de plus amples recherches sont requises, et encore d'autres ont indiqué des changements nécessaires soit dans les activités de construction ou opérationnelles.

La collection de données de base a requis presque 100% des ressources d'environnement de la compagnie pour les premières quelques années. Ensuite, parce que la construction commençait, la deuxième étape a pris de l'importance. Les activités de contrôle et l'inauguration des programmes de recherches spécifiques sont devenus suprêmes.

Les programmes de contrôle sur l'environnement et la détermination de l'impact concernant la disposition à long terme de l'eau salée de la région de la mine, ont été lancés. Une station mobile du contrôle de la qualité de l'air obtient des données de base sur les concentrations de bioxide de soufre et sulfure d'hydrogène, ainsi que sur la vitesse et la direction du vent. Une station météorologique opère conjointement avec le Service Canadien de l'Environnement Atmosphérique afin d'obtenir des données qui sont ensuite envoyées au gouvernement pour l'utilisation publique et privée. Syncrude utilise ces données afin de déterminer les différents paramètres de construction.

Les systèmes d'écoulement d'eau d'une région de 32,400 hectares (125 milles carrés) seront dérangés. Des études ont été faites depuis plusieurs années afin de prédire, décrire et modifier les effets du développement des sables bitumineux sur ces systèmes aquatiques. Les écoulements d'eau de surface dans la région de McMurray présentent plusieurs problèmes potentiels d'environnement. Ceux-ci sont de nature régionale et ne peuvent pas être définis ou résous adéquatement par des études poursuivies sur des concessions individuelles, donc un certain nombre d'agences gouvernementales et industrielles coopèrent à des études hydrogéologiques de la région.

## DISPERSION MAXIMALE

L'operation d'une usine de pétrole brut synthétique a pour résultat la production de larges volumes de bioxide de soufre, bioxide de carbone, oxydes de nitrogène et de vapeur d'eau. C'est important que l'usine soit planifiée afin de réduire les niveaux d'émission et pour encourager la dispersion maximale de ces gaz lorsqu'ils atteignent l'atmosphère. Parce que la climatologie est de nature régionale, un certain nombre de personnes ayant des concessions dans les sables bitumineux poursuivent un programme pour mesurer les conditions atmosphériques qui contrôlent la dispersion gazeuse dans la région de McMurray.

Syncrude maintient un laboratoire-environnement en place dans la région de McMurray pour fournir des données de base chimiques et physiques immédiates; pour contrôler l'impact sur l'environnement des activités de construction et pour fournir une aide à plusieurs groupes de conseillers et individus dans ce métier.

## L'HABITAT DES OISEAUX

Une grande variété d'oiseaux utilisent la région des sables bitumineux de McMurray pour des arrêts pendant la migration, pour la reproduction, pour faire leurs nids, et lorsqu'ils muent. Le développement de la région pourrait éliminer un habitat favorable, aquatique autant que terrestre, et l'établissement d'habitats défavorables, en particulier aquatiques, qui pourraient s'avérer attirants mais périlleux. Le problème le plus sérieux qui pourrait être créé est celui du "graissage" des oiseaux atterissant dans des "bassins de résidus", l'endroit dans lequel les effluents du procédé se déverseront. Cette masse d'eau pourrait demeurer accessible lorsque d'autres sont gélées et pourrait donc attirer le gibier d'eau.

Reconnaissant les possibilités de hazards dans le bassin de résidus, Syncrude poursuit des recherches concernant trois aspects différents du problème, amélioration de l'efficacité du procédé de séparation, donc diminution de la quantité de bitume qui se déverse dans le bassin de résidus; amélioration des méthodes pour renfermer dans une plus petite région du bassin, tout bitume qui s'y déverse; et le développement des éléments de prévention qui empêcheront les oiseaux d'atterrir sur le bassin. Ayant deux ans avant que les résidus de l'usine se déversent dans le bassin, le personnel des recherches sont convaincus que ce problème peut être réduit au minimum avant qu'il devienne réel.

La région du développement des sables bitumineux a quelques endroits d'habitats favorables pour les animaux à fourrure et les élans et cerfs. La construction d'usines de sables bitumineux entraîne le dégage-

birds from landing on the pond. With two years before the first tailings are discharged from the plant, research personnel are confident that this problem can be reduced to a minimum before it becomes a reality.

The region of tar sand development has some areas of favourable habitat for fur-bearing animals, and moose and deer. Construction of tar sand plants entails clearance of vegetation and consequent changes in habitat and altered surface hydrology. To counter this impact, studies are being undertaken to determine the extent of the disturbance and to develop reclamation and revegetation plans to encourage the re-establishment of displaced animal populations.

## RECLAMATION

The Syncrude project will disturb approximately 6,100 hectares (15,000 acres) of land in terms of topsoil removal. It is necessary to reclaim, as distinct from restoring, the disturbed area to a useful, biotically active state. This is reflected in two of Syncrude's reclamation objectives:
1) the area left as land must be capable of supporting plant and animal life; and 2) any water body remaining must be of a quality which will allow for the continued maintenance of plant and animal life.

In terms of revegetation, Syncrude has set its objective, the establishment of a permanent, self-supporting and maintenance-free plant community on the disturbed area. This will begin with the refilling of the mine pit with clean tailings sand from the processing plant, topped with muskeg retained from the original clearing or other materials capable of supporting growth. The natural sequence of succession will be imitated as closely as possible. Native species of smaller plants, such as grasses, legumes and herbs, will be introduced, followed by the establishment of trees and shrubs. The use of species native to the area is expected to ensure greater success than the planting of agronomic hybridized plant species, which might not be self-sustaining.

The soil studies commissioned by Syncrude are closely integrated with revegetation investigations and are being directed toward providing optimum conditions for germination and growth of the plant species selected for revegetation.

## ARCHAEOLOGY

Archaeological investigations revealed a relatively rich resource of artifacts. Excavation and analysis of a portion of the site has shed light on the aboriginal modes of stone technology and strengthened the prehistoric data base of the region considerably. Research is being conducted to identify the archaeological potential of the area and to preserve existing archaeological information.

The wide range of elements affected by tar sand development and the number of variable process features make the interplay between development and ecosystem immensely intricate. The accumulation of the appropriate environmental information is only the beginning of an essential sequence of events leading to good environmental decisions. Adequate data must be developed and integrated into an understandable whole to allow control over man-induced changes in the environment. Thorough and conscientous planning, innovative concepts and a continuing diligent and rational cooperative effort between industry and government are all required for maximum protection of the natural environment.

ment de la végétation et des changements qui résultent dans l'habitat et l'hydrologie d'une surface modifiée. Pour contrer cet impact, on entreprend des études afin de déterminer la mesure de la perturbation et pour développer des projets de réclamation et revégétation afin d'encourager le rétablissement des populations animales qui ont été déplacées.

## RECLAMATION

Le projet Syncrude va déranger environ 6,100 hectares (15,000 acres) de terrain en termes de l'enlèvement du sol de surface. C'est nécessaire de réclamer, à distinguer de la restoration, la région perturbée en un état utile et biotiquement actif. Ceci est reflété dans deux des buts de réclamation de Syncrude:
1) la région laissée comme terrain doit être capable de maintenir la vie animale et végétale et 2) n'importe quelle masse d'eau qui reste doit être d'une qualité permettant le maintien continu de la vie animale et végétale.

En termes de revégétation, Syncrude s'est donné comme but, l'établissement d'une communauté végétale autosuffisante et n'ayant pas besoin d'entretien à l'endroit perturbé. Ceci commencera avec le remplissage de la fosse minière avec des résidus de sable propre provenant de l'usine de transformation, recouvert de muskeg gardé depuis le dégagement du début, et d'autres matériels capables de maintenir la croissance. La séquence naturelle de succession sera imitée aussi étroitement que possible. Les espèces indigènes de plantes plus petites telles l'herbe, les légumes et les herbes, seront introduites, suivies par l'établissement d'arbres et arbustes. On estime que l'utilisation d'espèces indigènes de la région assurera un plus grand succès que le fait de planter des espèces de plantes agronomiques hybridées, qui pourraient ne pas se suffire.

Les études du sol exécutées sur commande de Syncrude sont étroitement intégrées avec les investigations concernant la revégétation et sont dirigées vers le but de fournir l'optimum des conditions pour la germination et la croissance des espèces végétales choisies pour la revégétation.

## ARCHEOLOGIE

Des investigations archéologiques ont révélé une ressources relativement riche d'objets . façonnés. L'excavation et l'analyse d'une partie du site ont éclairé la question des modes aborigènes de la technologie de la pierre, et ont fortifié considérablement les données de base préhistoriques au sujet de la région. On fait des recherches afin d'identifier le potentiel archéologique de la région et de préserver les données archéologiques actuelles.

La série variée d'éléments influencés par le développement des sables bitumineux et le nombre de différentes caractéristiques des procédés rendent l'association d'effets entre le développement et le système écologique extrêmement complexe. L'accumulation d'informations appropriées sur l'environnement n'est que le commencement d'une séquence essentielle d'évènements menant à des bonnes décisions concernant l'environnement. On doit développer et intégrer des données adéquates dans un ensemble compréhensible pour permettre un contrôle sur les changements amenés par l'homme dans l'environnement. Des projections approfondies et consciencieuses, des idées innovatrices et un effort coopératif continu, diligent et rationnel entre l'industrie et les gouvernements sont tous requis afin d'obtenir une protection maximale de l'environnement naturel.

EXPO-SCIENCES DU CANADA - WIDE SCIENCE FAIR
FINALIST/E

**MAY 15th TO 23rd, 1976**

**BRANDON**

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YOUTH SCIENCE FOUNDATION • FONDATION SCIENCES JEUNESSE •


## Let's get things straight

In 1850 the average farmer produced enough food for four people.

In 1900 he fed seven.

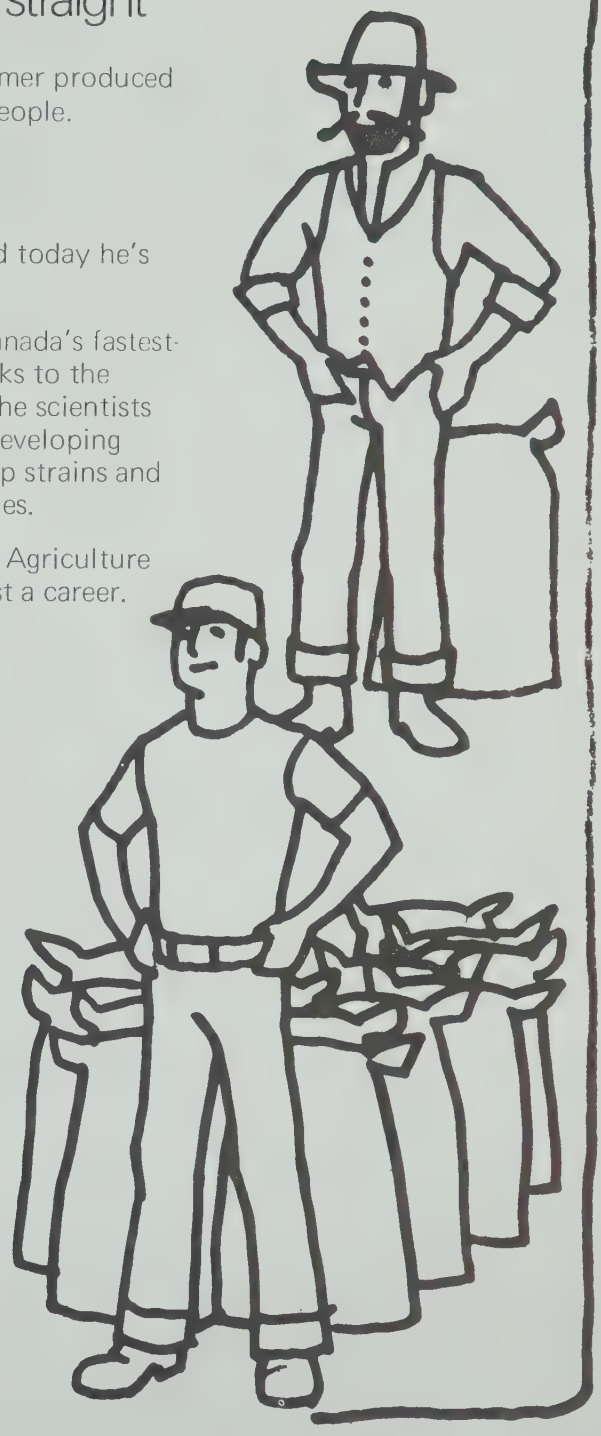
By 1940 he fed 11.
By 1960 he fed 28. And today he's feeding 52.

Agriculture is one of Canada's fastest-growing industries thanks to the farmers and thanks to the scientists who support them by developing better livestock and crop strains and better farming techniques.

Scientific research with Agriculture Canada is more than just a career.

Hon. Eugene Whelan, Minister
L.D. Hudon, Deputy Minister

Agriculture Canada




# FIFTEENTH ANNUAL CANADA-WIDE SCIENCE FAIR

# QUINZIEME EXPO-SCIENCES PAN-CANADIENNE

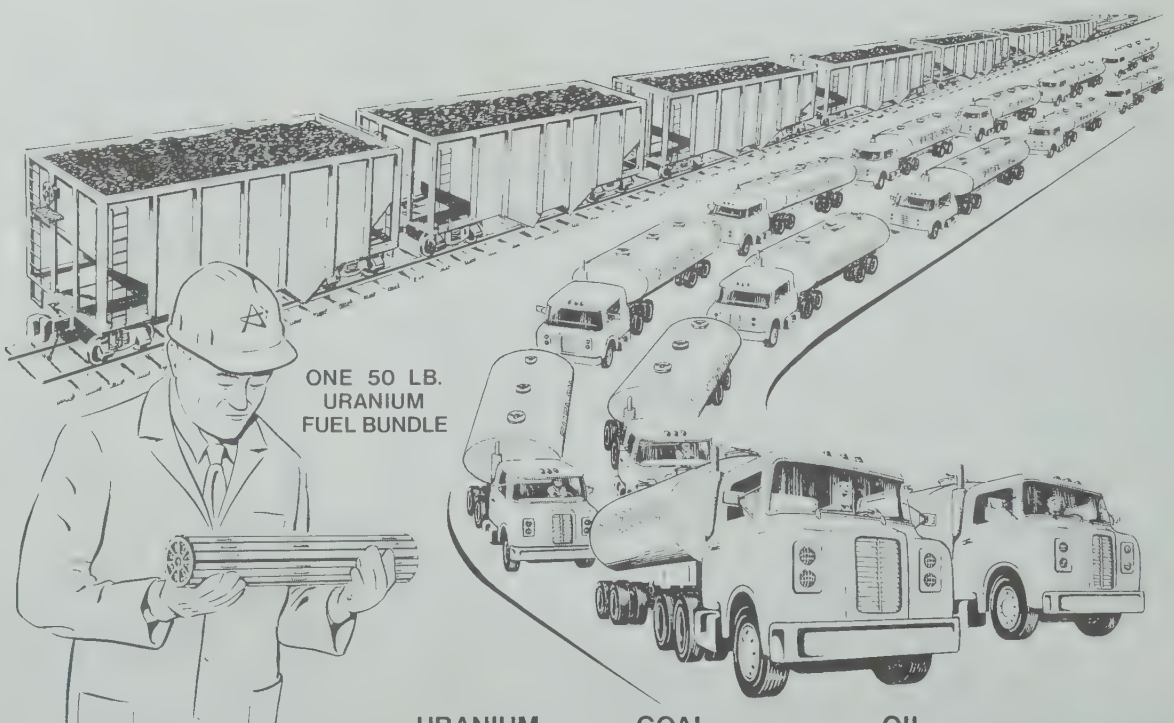
*Inspecting uranium fuel bundles.*

# Bundle of Energy

Natural uranium fuel, made from uranium mined, milled and processed in Canada, is the energy source for Ontario Hydro's Pickering Generating Station, the largest operating nuclear power plant in the world.

After being converted to uranium dioxide, the fuel is formed into small pellets which are inserted into a zirconium alloy tube. Twenty-eight tubes are then fastened together to form a fuel bundle. The drawing indicates how much energy a single fuel bundle can provide, as compared with coal and oil.

One consequence of the energy crisis has been a new appreciation of the importance to Canada of her large uranium fuel resources and of the Canadian-developed system that makes this country virtually self-sufficient in all aspects of nuclear power production.

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Atomic Energy of Canada Limited

Head Office: 275 Slater Street, Ottawa K1A 0S4

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# PREDICTING AIR QUALITY

Syncrude will have to remove over 1300 tonnes of sulphur every day from the bitumen it processes, and 143 tonnes of this will be emitted to the atmosphere as $SO_2$. In 1973 the Alberta government calculated that emitting 286 tonnes of $SO_2$ (=143 tonnes sulphur) through Syncrude's 183 m tall stack would create ground level concentrations of .04 parts per million, well within the provincial standard of .17 ppm averaged over one hour.

The government's calculation was accurate enough, but it did not take into account the complete range of conditions which affect dispersion. The ability of the atmosphere to disperse pollutants depends on the changes (with height) of air temperature and air movement, i.e. the temperature profile and the wind profile. Individual temperatures are not significant; it is the relationship between the temperature at a given level and at the levels above and below which determines whether the atmosphere is stable, neutral or unstable. In a **stable** atmosphere a parcel of air will tend to remain at one level, and if displaced will try to return to its original level. In a **neutral** atmosphere, the same parcel would tend to stop at any level to which it was displaced. In an **unstable** atmosphere, however, a moving parcel will simply keep going.

The government's 1973 calculation was based only on conditions of neutral stability. Since that time Syncrude has been determining how often the atmosphere fits into each of the three stability classes, and has modified the government's prediction accordingly. During the studies several new variables have been identified, and the predictions are expected to get more accurate as research continues.

This type of study is used to predict environmental impact, and to allow Syncrude time to formulate operating strategy to remain within the limits specified by Alberta's Clean Air Act. It is one of a variety of innovative environmental programs undertaken by Syncrude.

Syncrude

# ENVIRONMENT

BULLETIN

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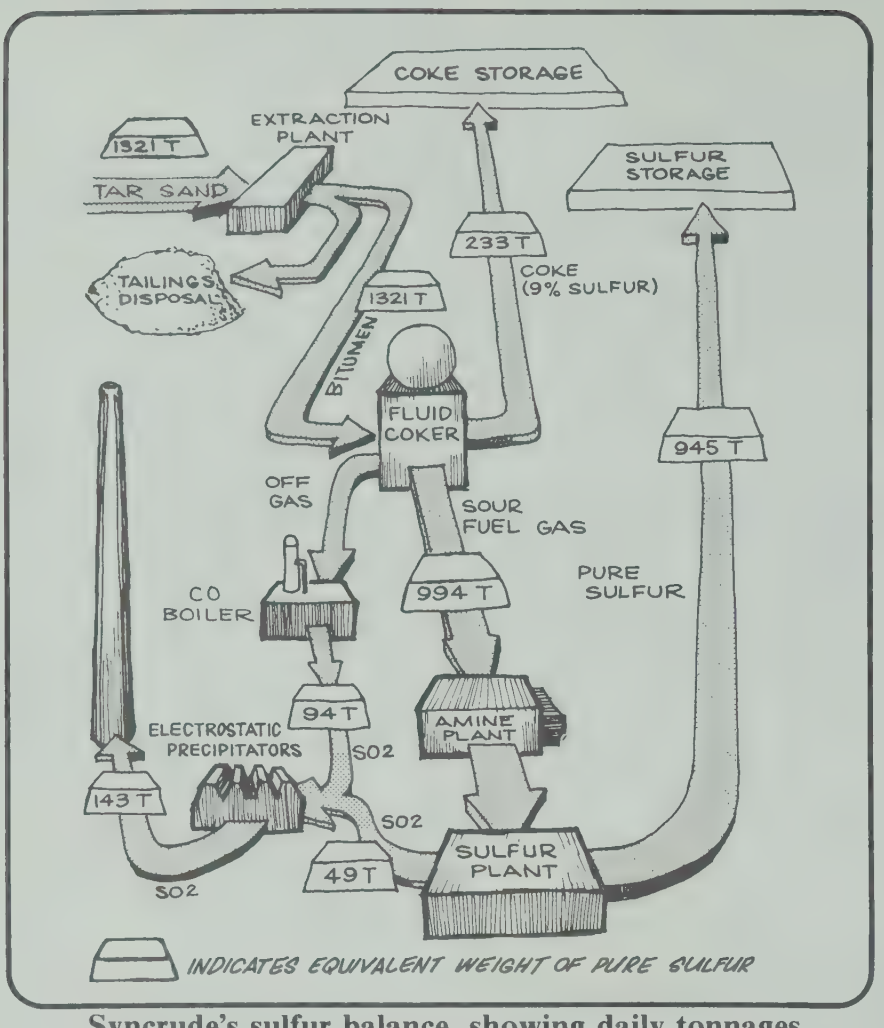



**Syncrude's sulfur balance, showing daily tonnages**

## A study that you published stated that you might violate the Clean Air Act over one hundred times a year. How can you justify this?

The study was a mathematical prediction of how Syncrude's plume would have behaved under the atmospheric conditions prevalent during the 1974-75 study period. So many different factors can affect the dispersion of pollutants in the atmosphere that simplifications and assumptions have to be made to reduce the mathematics to a manageable level. Syncrude's equation used quite pessimistic simplifications, because the company wanted to know what the worst case could be.

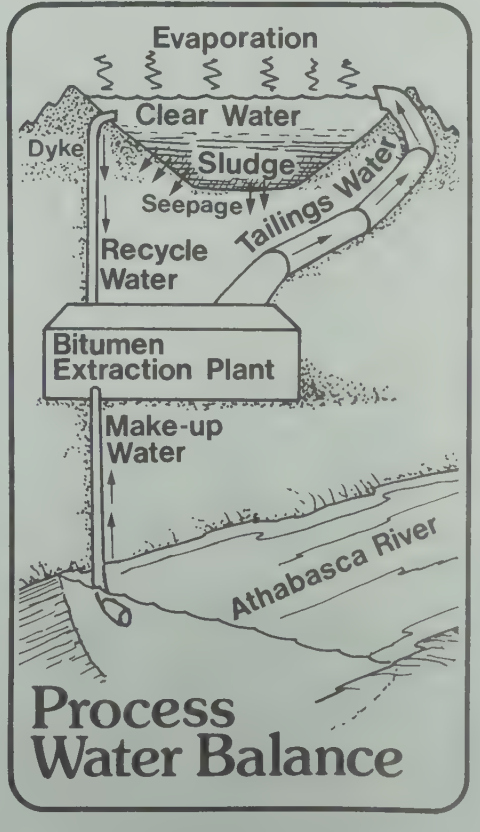
Why would we undertake such a study? Because a little advance warning is useful, especially if it says "You could break the law if these conditions occur". The advance warning has prompted Syncrude to investigate means to adjust the speed and temperature of the gases leaving the stack, and to learn to predict the periods of limited mixing that cause high pollution levels. In short, the study was an educated guess, a guess that Syncrude is using and improving on to predict the effect of $SO_2$ emissions. The study was certainly not published as a statement of intent to break the law.

## Why does Syncrude need a tailings pond?

The process which extracts bitumen from tar sand requires millions of gallons of hot water daily, all of which is ultimately discharged to the tailings pond along with all of the tar sand solids. The tailings water resulting from the process is not of sufficient quality either to be discharged to the environment or to be reused in the process without clarification. The tailings pond has been designed to allow separation of the coarse sand solids and adequate settling of suspended fine particles of clay to provide water that is suitable for reuse in the plant. Because of the tailings pond, Syncrude has been able to adopt a policy whereby no process-exposed water will be discharged to the Athabasca River.

Of all the water that enters the plant, only about half will be available for recycling after it has been discharged from the plant to the tailings pond. Evaporation from the pond roughly balances the amount of snow and rainfall that is added to the pond each year. A certain amount of water will be retained in the coarse fraction of the tailings solids, but the largest portion of the lost water will be tied up with the fine clay as sludge. Because this water is no longer available for recycling, about half of the plant's requirements will have to be made up with water from the Athabasca River.

The actual area of the tailings pond surface is important in the recycling calculations. The water clarifies from the top down, as the clay particles settle out. Since the clearest water will occur near the surface, it is important that a large surface area be provided for settling. Mainly for this reason, the tailings pond is planned to cover an area of about 10 square miles.



## How is the tailings pond constructed? Won't it leak?

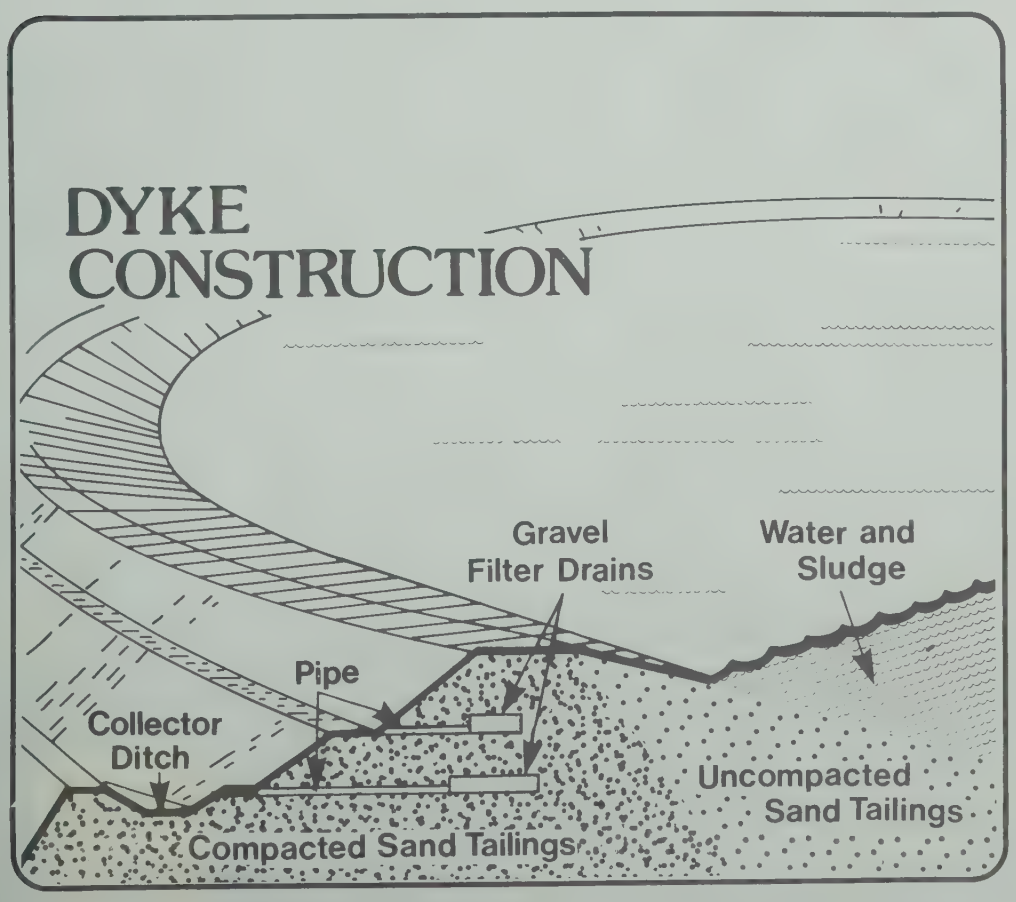
The land that the pond will cover is relatively flat. The edges of the pond will be built up with a dyke made of tailings sand (the coarse material left after bitumen is extracted from tar sand). The dyke will rise about 80 feet on the average, but will vary in height depending upon the ground contours. For instance, at one location where Beaver Creek has cut into the plateau, the total height will be in the range of 270 feet. An earthen "starter dyke" has already been built at this point and will rise to 135 feet.

Dyke construction will proceed in stages called "cells", each about 140 feet wide, 2000 feet long and from 5 to 8 feet high. The first step in building a cell is to bulldoze a berm of sand around the perimeter of the cell. The tailings are then pumped to the cell where the sand is spread and compacted. The water and fine solids that are not trapped in the sand that has been compacted are decanted into the tailings pond.

Not all of the water drains out of the dyke during construction. Water will seep from the dyke for a period of years. This water will be collected in ditches around the outside toe of the dyke and returned to the pond.

A gently sloping "beach" of uncompacted sand will extend into the tailings pond and stabilize the inside slope of the dyke. Rain and melting snow threaten to erode the outside face of the dyke, so a joint revegetation research project involving two Syncrude departments, Conservation and Environmental Affairs, has been started. It is hoped that a cover of grasses and shrubs can be grown right on the tailings sand.

The fine clay particles suspended in the tailings water will tend to clog the pore spaces of the ground beneath the pond as they settle. Just how complete the sealing of the pond bottom will be is the subject of continuing investigation and monitoring. Methods of improving the sealing or even changing the entire tailings disposal concept are being examined by Syncrude's Engineering and Research Departments.




## PUBLICATIONS FROM SYNCRUDE

Over the past year, eleven Environmental Research Monographs have been published by Syncrude. Individuals and organizations can request specific monographs or be included on the mailing list for forthcoming publications by writing to Environmental Affairs, Syncrude Canada Ltd., 9915 - 108 Street, Edmonton, Alberta, T5K 2G8.

## Summaries of some recent publications

**1975-1 An Entomological Reconnaissance of Syncrude Lease #17 and its Environs**

A three week field study of insects occurring on Lease 17 was carried out. Pitfall traps, window traps, malaise traps and manual collection techniques were used to gather insects. Besides providing a list of insect species on the lease, the study names several species whose numbers could be used to monitor changing environmental conditions.

**1975-2 The Hydrology of Lease #17: A Report on Studies Completed in the Year 1973**

The natural surface drainage of lease 17 had to be diverted before mining could begin. The flood frequency curves normally required for the design of a new drainage system could not be prepared directly because no flow records existed. Using one year's local runoff data, and values derived from other northern Alberta streams, flood frequency curves were estimated.

**1975-3 A Baseline Environmental Study of Ruth Lake and Poplar Creek**

The diversion of Beaver Creek into Ruth Lake and Poplar Creek will cause changes in the downstream ecosystems. A study was undertaken of the "before" conditions. Subsequent research will monitor changes in the waterbodies affected by the diversion.

Ruth Lake was found to be shallow and moderately eutrophic, supporting moderate phytoplankton populations in the summer. Brook sticklebacks and fathead minnows reproduce in the lake.

Poplar Creek is a small brownwater stream, slightly alkaline, and supporting about 70 benthic insect taxa as well as grayling, white suckers and pike.

**1975-4 Inventory Studies of Birds On and Near Crown Lease #17, Athabasca Tar Sands, 1974**

The 1974 phase of a three year survey of birds included regular monitoring of 30 water bodies, in order to relate habitat factors to species occurrence. Over 150 species of birds were identified on Syncrude's lease 17, either nesting or stopping over during migration. Statistical analyses were used to identify species which occupy similar habitats, and to determine the habitats with which species were normally associated.

**1976-1 A Predictive Study of the Dispersion of Emissions from the Syncrude Mildred Lake Plant**

Estimates of the atmospheric conditions affecting the dispersion of the Syncrude plume were applied to a theoretical dispersion model. Syncrude's potential compliance with provincial airstandards was estimated to fall within the 98.6 - 99.3% range, given the conditions of the 1974-75 study period and the assumptions made in the model.


## SYNCRUDE ENVIRONMENT BULLETIN

The Syncrude Environment Bulletin is published to provide a continuing report on the environmental aspects of the Syncrude Project, and to aid in opening a two-way line of communication with the public. The Bulletin is distributed without charge to individuals and organizations concerned with the ecology of the tar sands region. For more information about Syncrude's environmental activities, or to be included on the mailing list please send your request to:

**Syncrude Environment Bulletin**
**9915 - 108 Street**
**EDMONTON, Alberta**
**T5K 2G8**

Public and High School students are requested to include the name of their school.

**Bulletin V-I, Spring 1977**



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# SYNCRUDE: ENVIRONMENT

## Ruth Lake — Poplar Creek Environmental Baseline Study

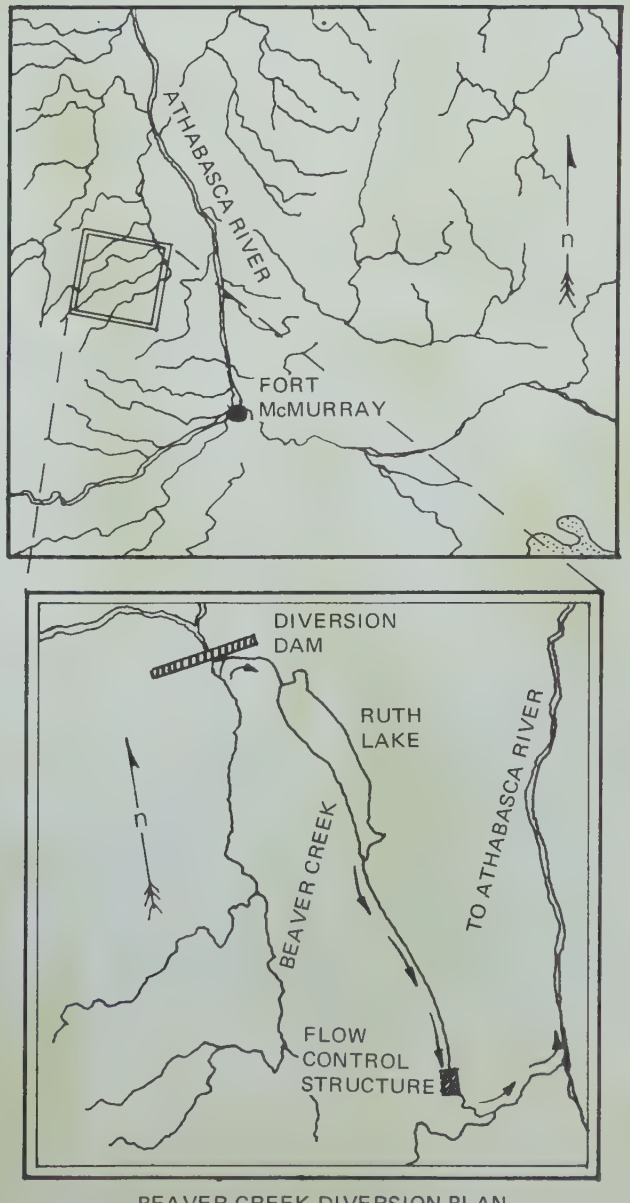
As a continuation of its program to acquire baseline information for future environmental monitoring, Syncrude has commissioned Renewable Resources Consulting Services Ltd., Edmonton to conduct a research study of Ruth Lake and Poplar Creek during 1974.

The study will document background information on conditions as they exist prior to the diversion of Beaver Creek into this aquatic system. The diversion will eliminate the lower reaches of Beaver Creek which (at present) flows through the future location of the Syncrude mining area and retention pond.

The general objectives of the research study are to:

1. determine the magnitude and value of the aquatic resource
2. establish quantitative baseline information that can be utilized for comparison of future conditions, and
3. establish a basis on which to detect changes in the aquatic environment for the purpose of future objective evaluation of the impact of the creek diversion.

This research study complements the baseline survey which was conducted on Beaver Creek in 1971 (see "Beaver Creek: An Ecological Baseline Survey", Environmental Research Monograph 1973-2, Syncrude Canada Ltd.).




BEAVER CREEK DIVERSION PLAN

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# Archaeological Surveillance

The construction of a buried water pipeline on Syncrude's Lease #17 does not appear to have endangered or destroyed any potential archaeological resources along the construction route.

This is the opinion of the archaeologist who carried out a program of virtually continuous observation of the construction for a period of four weeks. Since nearly 75% of the 23,000 foot pipeline right-of-way traversed an area with high archaeological potential, the cutline and trenching operations presented a prime opportunity for further examination with regard to possible buried remains.

The surveillance was a follow-up to survey work carried out last summer, which resulted in the publication of Syncrude Environmental Monograph 1973-4: "Syncrude Lease #17, An Archaeological Survey".

# Regional Hydrogeological Study

The Oil Sands Environmental Study Group recently received a $50,000 grant from the Research Secretariat of the Alberta Department of the Environment to, in part, develop an Athabasca regional hydrogeological study.

The purpose of the program is to determine the present regional groundwater flow characteristics and to identify the chemical properties of the various aquifers. This will assist in assessing the effect of the regional groundwater system on the mining operation and surrounding watersheds. The study will provide the detail required to determine how the effects of the mining operations on the hydrological environment can be predicted and monitored.

The first phase of the study should require approximately five months to complete. This will assess the quantity and quality of data already possessed by the 19 OSESG company members and by public agencies, include some mapping and interpretation of existing data, and design a comprehensive, longer-term field and interpretation program.

Plans are to have the first phase study performed by Alberta hydrological consultants, guided by a senior review committee of noted Canadian hydrologists.

# The New Monographs

The flow of information from Syncrude to the scientific community and to the public at large, will be maintained this year through the publication of a number of environmental monographs.

The first, now in preparation, will be a survey of remote sensing technology and its applicability to the environmental study needs of the oil sands area. Defined as the measurement of environmental conditions on the surface of the earth, performed by airborne sensors, remote sensing technology provides an effective means of collecting information with which to measure conditions and to evaluate the significance of any change.

The report will include examples of surveys of this type which have already been completed by Syncrude.

The second monograph will concern a surficial hydrological investigation of Beaver Creek and Poplar Creek, both in the general area of Syncrude's Lease #17. These two watercourses will be affected by a diversion scheme. Preliminary work on this study was conducted during 1973 when considerable field work and a fairly extensive search for relevant hydrological data were undertaken.

These hydrological studies help Syncrude acquire an understanding of the overall water balance of the lease area; to investigate the difference between disturbed and undisturbed land and to establish design criteria for drainage structures.

# Beaver Creek Archaeological Quarry Site

Further investigation of what appears to be a large aboriginal quarry and workshop, the most extensive archaeological site discovered in the Lease #17 area, is being conducted this summer.

Timothy C. Losey has been commissioned by Syncrude to study the site, which was discovered during the 1973 preliminary archaeological evaluation of the region. It lies between the northern boundary of the lease and the Athabasca River, adjacent to Beaver Creek. Its determination as a quarry and workshop is based on the existence of a large quantity of flaking debris and an outcrop of raw stone material (limestone).

The objectives of the 1974 study are:

1. To delineate the extent of stone

quarry activity at the site in terms of both time and space.

2. To investigate possible techniques employed by aboriginal operators of the quarry to extract stone materials.

3. To identify technological processes used to manufacture stone tools and/or tool preforms at the site.

4. To determine the timing and degree of technological change, if any, as an assistance in dating satellite habitation sites.

5. To define the makeup of the stone so that it may be identified when found in locations outside the quarry.

6. To obtain and preserve for the benefit of future archaeological endeavors in the tar sands region any and all information available from the site.

# Environmental Study - Entomology

"A research proposal is invited from any qualified party to study insect populations in the Athabasca Tar Sands area of Alberta. The study should concentrate upon species' diversity, population density, relation to the ecosystem and implications of tar sand development on these parameters."

This was a portion of an advertisement which was recently placed in Alberta and B.C. newspapers by the Environmental Affairs Group, initiating one of the very few entomology studies carried out in northern Alberta. Throughout Canada, even fewer studies have been undertaken to estimate changes in insect populations caused by increasing industrial development and human intrusion.

The preliminary stages of the study will be conducted this year. Reconnaissance of the area and selection of sample sites will be made. In 1975 the selected sites will be sampled throughout the growing season. Laboratory work with identification of insect species will be finalized by the end of 1975. The results, with recommendations for areas of possible further work, will be submitted and published in monograph form by Syncrude in the spring of 1976.

# Environmental Affairs Group

As Syncrude's Environmental Engineer, Toivo Voksepp is involved in environmental concerns from an engineering point of view. Born in Estonia, he came to Vancouver with his family in 1951. After his graduation from the University of British Columbia in 1968 as a chemical engineer, he worked for a year and a half in the research and development aspects of copper hydrometallurgy in the Highland Valley of British Columbia. From 1969 to 1972 he was a development engineer for Sherritt Gordon Mines Ltd. in Fort Saskatchewan. He then returned to B.C. to join the staff of the provincial Pollution Control Branch, where his primary responsibility was the assessment of proposed or existing industrial pollution control programs. He was named to his present position with Syncrude in February, 1974.

**Toivo Voksepp**

# Syncrude Canada Ltd. Environmental Policy Statement

Syncrude Canada Ltd. works with the conviction that human use of the environment need not be destructive. With careful planning, based upon good information, man-altered and natural ecosystems can exist in harmony. In order to accomplish this planning, Syncrude considers resource development from a total-systems point of view. This comprehensive approach corrects the frequent tendency to attempt resolution of problems on a single purpose basis. The total-systems analysis approach leads to a plan of operations using the best practicable technology, both in resource development and in environmental protection. An ecosystem approach to resource development, an integral part of our approach, implies an understanding of and respect for the potential of natural systems and the use of the economy of nature, wherever possible.

Through a comprehensive program of surveillance of the effects of our technology and careful application of that technology, we aim to prevent accidental damage to the environment. Total effects will be examined by professional ecologists and study results provided to public representatives.


SYNCRUDE:
## ENVIRONMENT

SYNCRUDE: ENVIRONMENT is intended to provide a continuous report on the environmental activities of the Syncrude Project. It is distributed without charge to individuals and organizations concerned with the ecology of the tar sands region. To be included on the mailing list, send your request to:

**Syncrude: Environment**
**807 Baker Centre**
**10025 - 106 Street**
**EDMONTON, Alberta**
**T5J 1G4**


# We've Been Asked:

### "HOW MUCH WATER WILL THE SYNCRUDE PLANT TAKE FROM THE ATHABASCA RIVER?"

The water supply to the extraction plant is to be operated in three phases. Water will be pumped from the Athabasca River into an adjacent settling pond. Once the sediment has been removed, the water will be moved to Mildred Lake basin which will serve, in part, as a fresh water storage pond. From here, water will be fed by gravity to the process plant, as required. In the event of the water intake or settling pond encountering problems, water in the Mildred Lake basin will be sufficient to maintain plant operation for an extended period.

Water will be removed from the Athabasca River at an annual average maximum rate of 31,000 Imperial gallons per minute. As the water supply is built up in the storage pond and recycled from the retention pond, removal from the Athabasca River will decrease to about 17,000 gallons per minute (by the year 1992). The average minimum flow measured on the Athabasca river during February for the years 1958 - 1962 was 1,973,640 IGPM. Maximum extraction of water from the Athabasca therefore only represents 1.5% of total average minimum flow. Depletion of the water resource will, therefore, be minimized.


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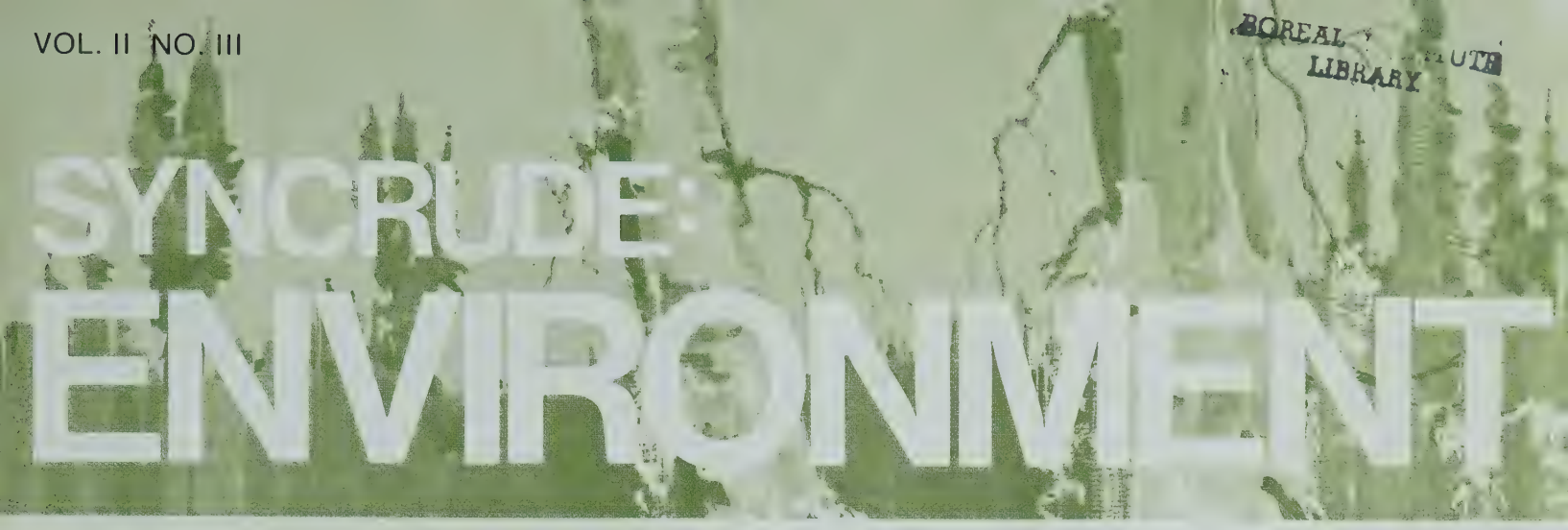


# REVEGETATION

The "balanced ecosystem", a revegetation procedure which provides for the establishment of a variety of native plants, may prove to be the most advantageous method of reclamation in the tar sands area, according to a research study being conducted by Syncrude and the Oil Sands Environmental Study Group.

All members of the OSESG have agreed to adopt this approach, which is designed to introduce a balanced plant community into the area to be reclaimed. The program uses plants indigenous to the Fort McMurray area, with a rich seed mixture of leguminous, herbacious and grass species. With a complex of native plants reproducing by seed or runner, the vegetation will become self-supporting, gradually changing in composition as other local plants seed-in from the surrounding undisturbed area. Once the plants are established, animal communities will follow, with the diversity of the species dependent to a great extent on the plant varieties.

As a facet of the study, Syncrude and the OSESG have paid for the services of Dr. Hermann Vaartnou of the Alberta Department of Agriculture. He has conducted preliminary investigations into the natural recolonization of disturbed areas throughout Alberta, particularly in the tar sands region. Many native plant species have been selected for revegetation on specific substrates and are now being grown under controlled conditions to assess their value in revegetation. Plots are also established throughout the province to culture enough seed to carry out the initial revegetation in 1976. To date, Dr. Vaartnou has completed four detailed reports, which will be combined in monograph form.

Previous to the Syncrude/OSESG Study, numerous reports were published on reclamation in industry but these were oriented toward use of agronomic hybridized plant species. Although these colonize land surfaces such as spoil piles, dikes, dams and tailings very rapidly, the initial aggressive growth precludes the invasion of longer-lived native species. Without this additional growth, the species initially established will die out slowly to expose bare errodable surfaces. Plass (1974) states that, for successful revegetation, "the operator . . . who has created a site capable of supporting a wide variety of plant materials is in a favourable position."

It is important to understand that "reclamation" implies reform of the land to a biotically active state, not necessarily in the same topographic conformation as was present before mining. "Restoration" implies reform of the land to the original physical configuration and biological state. No attempt is being made at the present time to "restore" the areas mined for tar sands.

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# Syncrude's Environmental Laboratory

Variations in surface water quality on and near Syncrude's Lease 17 during construction and operation are being monitored and measured against baseline information in a study presently being conducted at Syncrude's Environmental Laboratory, under the direction of laboratory supervisor, Wally Foster. Baseline samples are collected every six weeks from the watershed and analyzed for a total of 27 chemical and physical parameters.

In order to meet government criteria, water samples are also collected and analyzed at the Environmental Laboratory for determination of chemical and physical properties including chemical oxygen demand, oil and grease, suspended solids, pH, chlorides and odor number.

To ensure better protection against the advent or continuation of environmental damage, regular reports on surface water quality are produced for both internal and governmental review.

An ambient air monitoring program is also being carried out at Syncrude's Environmental Laboratory which is located on the construction site. A meteorological station, operated by Syncrude in conjunction with Atmospheric Services Canada, provides information daily. Continuous recordings are produced from several instruments including a solar gauge, anemograph, evaporation pan, rain gauge and maximum-minimum thermometers. A mobile air monitoring station, containing H2S, S02 and windflow records, is also being operated by the staff of the Environmental Laboratory. It provides baseline information and advanced operating experience, particularly during severe winter conditions. Reporting of air monitoring information to the Alberta Department of the Environment started in June, 1973.

# Remote Sensing

High and low-altitude remote sensing, which began in 1972, has now been completed on all of Syncrude's leases. This program originally consisted of the taking of a series of black and white, colour and infrared aerial photographs of an area about 45 miles square, including the Syncrude extraction and bitumen upgrading area, the initial mining site and the Beaver Creek water diversion region.

Photographic monitoring is continuing and has been expanded during the construction phase of the project. Interpretation of the photos has been conducted by specialist consultants. Earlier remote sensing which took place prior to the major construction activities is being used as baseline data against which to monitor changes in the environment.

Syncrude will attempt to use remote sensing for further environmental studies in the tar sands area, including satellite (Earth Resources Technology Satellite) and aircraft data obtained from multi-spectral scanner systems. The possibilities of using automated analysis and mapping systems based on computor processing of the scanner data are being evaluated. These systems may become major tools from environmental management.

A survey of remote sensing technology and its application to the environmental study needs of the tar sands area has been published as a monograph titled "Remote Sensing and the Athabasca Tar Sands: An Overview", (Environmental Research Monograph 1974-1, published by Syncrude Canada Ltd.). This monograph is based on Syncrude-commissioned work of Dr. Allan Falconer and James Nalbach through LGL Limited, Environmental Research Associates, including remote sensing imagery prepared by MachAir Ltd. of Calgary; interpreted by the Sibbald Group and Dr. Falconer.

The monograph is available from Syncrude for academic or scientific purposes.

# Ornithological Research Program

LGL Environmental Research Associates have been awarded a contract to continue development of baseline ornithological information on the species that make use of the water bodies in the Fort McMurray area.* This information will be used for future impact assessments and for experimental studies.

The first step in the study is to conduct a search of literature and reports pertinent to migratory waterfowl and shorebirds in the area. This will assist in establishing what is known of the species present, of their numbers and of their length of stay in the area. The literature search has been followed by a systematic inventory on the Syncrude lease and on nearby areas, which will fill the information gaps and provide detailed, intensive data on such subjects as migratory peaks of shorebirds and the use of the area by waterfowl for breeding and moulting.

* Migratory Waterfowl and the Syncrude Tar Sands Lease: A Report. Environmental Research Monograph 1973-3. Syncrude Canada Ltd.

# Environmental Affairs Group

Pictured above is the technical staff of the Syncrude Environmental Laboratory, from left to right: John Alessio, Kathy Schwartzenberger and Jerry Marchak.

In the spring of 1974, John Alessio graduated from Mount Royal College, Calgary, with a diploma in Environmental Quality Control and came to work in Fort McMurray as an environmental technologist. Working in both hydrology and climatology, John maintains the meteorological station, acts as Syncrude's weather forecaster and collects the various samples required for water analysis. At present he is involved in a meteorological study in the Athabasca region. This requires the daily release of minisondes, miniature transmitters carried into the upper atmosphere by balloons. The minisondes are tracked for half-an-hour while transmitting temperature, wind speed and direction information during their ascent. The data is tabulated and forwarded to the Meteorological Environmental Protection Agency to help establish atmospheric weather conditions in the tar sands region.

Kathy Schwartzenberger is responsible for water analyses. Kathy graduated from NAIT as a chemical technologist in 1972. She worked at the Alberta Pollution Control Laboratory on water and air pollution and, while there, took courses covering gas chromatography, atomic and infrared absorption and mass spectrometry. At the Syncrude Laboratory, she averages approximately 115 water analyses per month.

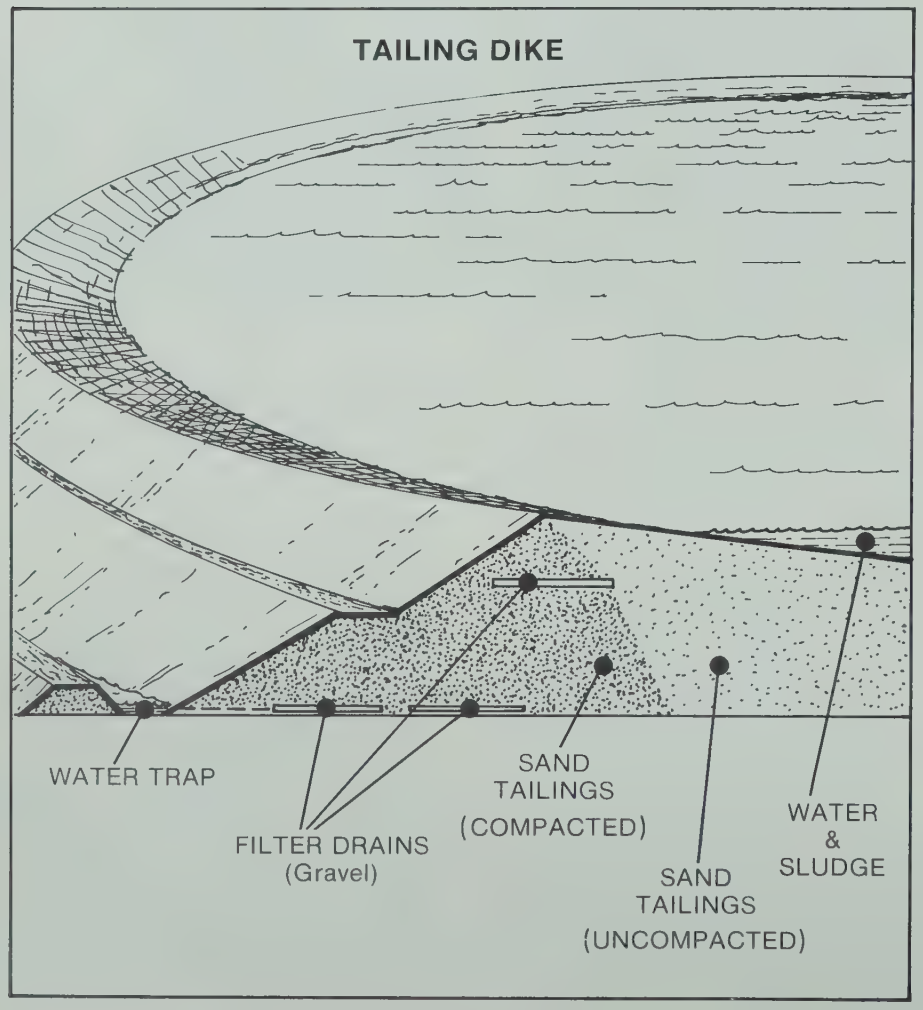
Jerry Marchak came to Fort McMurray in March when the Laboratory began operation. After graduating from the University of Alberta in 1973 with a B.Sc. in specialized chemistry, Jerry joined Syncrude to work in the analytical services group at the Research Laboratory in Edmonton. His present duties involve some supervision of the lab, quality control of the analytical procedures and special projects. The project under study at the present time includes involvement in the selection of locations and equipment for Syncrude's air quality monitoring stations as well as the potential for a cooperative tar sands air monitoring network with other prospective developers.

# How Are Tailings Dikes Constructed To Prevent Loss Of Liquid Tailings?

Dikes are constructed of the coarse sand remaining after the extraction process has been completed. This is piled around the pond area and compacted at the outer edge by rollers and other heavy equipment. The compacted "shell" is the strength of the dike, resisting the pressure of both the liquid tailings in the pond and the uncompacted sand on the inside face. The longer the dike exists, the stronger it becomes, as the sludge from the pond seals the face of the uncompacted sand tailings.

Seepage flow through and below the dike will occur to some extent and must be controlled to prevent internal erosion of the shell and sloughing from the outside face of the dike where the water emerges. To accomplish this a series of internal filter drains permits the water to flow through the dike to the outside face, where it is collected in interception ditches and piped back into the pond.

Water pressure inside the dike will be monitored by the use of piezometers.




# Oil Sands Environmental Study Group

Recently, a relatively close working relationship has been established between the federal and provincial governments for research into the environmental aspects of tar sands development. To prepare a preliminary research program outline for 1975-1986, along with a projection of future requirements, seven technical committees have been formed: hydrogeology, hydrology, atmospherics, land use, terrestrial fauna, aquatic fauna and vegetation. Both levels of government are looking to the Oil Sands Environmental Study Group to represent industry on these committees.

Syncrude will represent the OSESG on the Vegetation and Terrestrial Fauna Committees.

## SYNCRUDE: ENVIRONMENT

SYNCRUDE: ENVIRONMENT is intended to provide a continuous report on the environmental activities of the Syncrude Project. It is distributed without charge to individuals and organizations concerned with the ecology of the tar sands region. To be included on the mailing list, send your request to:

**Syncrude: Environment**
**9915 - 108 Street**
**EDMONTON, Alberta**
**T5K 2G8**

VOL. III NO. 1

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# SYNCRUDE ENVIRONMENT

ARCHAEOLOGY

# THE BEAVER CREEK SITE:

## A PREHISTORIC STONE QUARRY ON SYNCRUDE LEASE #22

The discovery of stone flakes near Beaver Creek, under an overturned tree stump, told archaeologists of the potential existence of an ancient quarry which produced the material for stone tools and weapons. This locality was discovered during an archaeological survey of Syncrude's Lease #17 and parts of #22 in 1973. The superficial evidence recorded upon the discovery of the site indicated that it was apparently attractive enough to repeatedly draw aboriginal peoples to gather or mine stone for fashioning into implements.

Artifacts from stone tool manufacture can serve a number of purposes in reconstructing prehistoric lifeways. The scarcity of known archaeological sites in the lower Athabasca River drainage, the vulnerability of the location of the Beaver Creek quarry with reference to future developments in the tar sands and the rare opportunity to study stone tool manufacture in the Boreal Forest emphasized the need to excavate and study a portion of the site.

In the summer of 1974, a team of archaeologists under the direction of Timothy Losey and field direction of Cort Sims spent 1500 man hours excavating the site, carefully extracting artifacts for further analysis in the laboratory.

Some 30,075 artifact items were collected, inventoried and analyzed. The artifacts ranged from flakes and waste detritus to projectile points (possibly for spearheads and arrowheads) to scrapers (possibly for removing the flesh from hides) to hammerstones (possibly for manufacturing implements) and others.

Taken together, the finished tools and other pieces plus the waste materials constitute a body of evidence pertaining to a total technological process carried out at some remote time period. The examination of the artifact sample indicated how material was procured, fabricators selected, the cortex removed and tools thinned and shaped.

This work done at the Beaver Creek Quarry was also compared with that carried out at other quarries in North America. The archaeologists devised a classification system which allows the artifact sample to be accurately quantified and to be compared to other artifact collections. The adoption of this system would allow for continuing progress in interpretation of quarry sites.

It was determined that this site was repeatedly visited for short periods by small groups of prehistoric hunting and fishing peoples and used as a rudimentary industrial centre.

It was also a preliminary conclusion of the work that the majority of the artifacts at the Beaver Creek Site are probably the result of a relatively late occupation of the site. This late occupation could date mostly between 300 A.D. and 400 A.D. However, one artifact suggests a possible earlier occupation of between 4,000 to 8,000 B.C.

This quarry site may constitute the basic reference from which interpretation of adjacent sites will proceed and may well play a key role in unravelling the prehistory of the tar sands region of northeastern Alberta.

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## Beaver Trapping Program

Jules Flobert, an experienced trapper of Fort McMurray, is currently cropping the beaver along Beaver Creek and its tributaries within Lease 17 under permit from the Fish and Wildlife Division.

The fairly large beaver population is occupying and damming areas presently under construction or areas that are scheduled to undergo construction in the near future. Efficient drainage of these areas is essential for continuation of site activities, necessitating removal of the beaver and their dams. Because the survival rate of relocated beaver at this time of year is very low, conventional rather than live-trapping methods are being used.

To assure that all the beavers in a lodge are trapped, traps must be set at each of the numerous runway entrances to the lodge. The runway locations are indicated by areas of bubbly ice, and the entrances of these to the lodge are located by probing through a hole chopped in the ice with a crooked feeler stick, as pictured. Before setting the trap in the entrance, the feed placed in the runway by the beaver is fished out to prevent interference with the trap. The snare is set into the bottom of the runway entrance on the center pole in the photo. The purpose of the other poles is to prevent the beaver from skirting around the trap.

## 1974 Ruth Lake/ Poplar Creek Studies Complete

Collection and documentation of baseline data on the physical, chemical and biotic characteristics of Ruth Lake and Poplar Creek is complete for 1974. The study, carried out by Renewable Resources Consulting Services Ltd. of Edmonton, was done to provide the baseline information necessary to predict, describe and, if needed, modify the effects of the diversion of Beaver Creek through these water bodies. Beaver Creek, which presently flows through the designated mining area, will be diverted from its natural channel into Ruth Lake and Poplar Creek to allow mining operations.

The study was designed to meet these objectives:

RUTH LAKE

1. Determine the morphometry (depth, width, volume, shoreline length, etc.) and the substrate or bottom characteristics.

2. Measure physical factors such as temperature, dissolved oxygen concentrations, levels of selected chemical parameters, and water transparency.

3. Sample the biota to determine the composition, abundance and fluctuations in aquatic plants, microscopic organisms (zooplankton and phytoplankton), bottom dwelling organisms (benthos) and fish fauna.

POPLAR CREEK

1. Determine resident populations of fish and the physical characteristics of the stream as related to fish.
2. Determine the composition, abundance and diversity of bottom dwelling fauna in the stream.

Field studies began in late March and continued to mid-September, enabling sampling to be done for each season. Ruth Lake was sampled bi-monthly and Poplar Creek monthly for physical factors and dissolved oxygen. Additional surveys and sampling were done for Lake morphometry and substrate, aquatic plants and fish.

Generalizing from the results, Ruth Lake can be described as a small, shallow, moderately eutrophic lake. It is littoral in nature, that is, it is characterized by traits typical of shore areas, and stagnates in winter. It has a limited fish fauna with brook sticklebacks and fathead minnows forming reproduction populations. Other species are prevented from inhabiting the lake by the low winter oxygen concentrations.

Poplar Creek is a small, brown-water stream tributary to the Athabasca River. It can be divided into two sections -- a lower section with lower gradient and fewer riffles and an upper section with steeper gradient and a higher proportion of riffles. Fish collections indicate a resident reproducing population of grayling in the upper section and probably of white suckers throughout. Some pike occur in the lower section.

Ecological baseline studies ideally should be done over a number of years and at all seasons of the year in order to describe both seasonal and annual changes in natural conditions. Continuing studies are planned for 1975.

## Soil Studies Continue

Syncrude is continuing soil studies as an essential part of the reclamation and revegetation research. A contract has recently been awarded to a team of soil scientists from the University of Alberta, headed by Drs. Marvin Nyborg, Bill McGill and Mike Rowell. The research is being closely integrated with investigations by Dr. Hermann Vaartnou (of the Plant Industry Laboratory, Department of Agriculture) into plant species to be used for revegetation. The soil studies are being directed towards providing optimum conditions for germination and growth of the plant species selected for revegetation. The scope of the study involves four aspects, with special reference being made to means of enhancing soil chemical, microbiological and physical properties;

1. To determine the activity level (nutrient release, microbial and microfaunal activity, and other transformations) in soils under previously-established vegetation on tailing dikes, mined land and pipeline rights-of-way: all with the purpose of finding if the soil-plant system will remain stable.
2. To determine the initial properties and probable long-term changes for various soil materials and mixes likely to be used in reclamation and revegetation of mined land and other disturbed areas. For example, is residual oil toxic to plants or soil micro-organisms; does sodium from tailing sand cause clay dispersion problems in surface soil; does added peat decompose more rapidly than new plant material is produced; and does residual oil induce nitrogen deficiency in vegetation?
3. To determine and estimate physical, chemical and biological conditions and alterations in soils stored (for periods of 1 to 20 years) for later use in reclamation of surface mined areas. Also, to find ways of preventing any undesirable changes in stored soils should they occur.
4. To determine the soil properties necessary for survival of each of those native plant species which will most probably be used in revegetation of disturbed areas and to determine the range of soil conditions each species will tolerate.

## Environmental Affairs Group

**Peter Lee**

An Eastern Canadian, Peter Lee attended the University of Western Ontario in London, Ontario and Lakehead University in Thunder Bay,Ontario where he graduated with Bachelor of Arts, majoring in Geography. Summer employment during these years involved various experiences in the forest industry in Ontario. After coming out west Peter joined the Syncrude Environmental Affairs Group in August, 1973 and now holds the position of Environmental Coordinator - Ecology. An important part of his job is to represent Syncrude on the OSESG (Oil Sands Environmental Study Group). As such he discusses and commissions cooperative regional research programs with other members of industry. Peter also assists in coordinating Syncrude's ecological consultant's programs. His involvement begins with the recognition of the need for a program and follows through to the acceptance by Syncrude of the final report and the appropriate follow-up action.

**Ellie Urlacher**

Ellie Urlacher is secretary to the Environmental Affairs Group. A native Albertan, Ellie spent her early years in several small Alberta towns, but attended high school in Edmonton. Here she received her academic and secretarial training. Before joining Syncrude in August, 1973, she had two previous secretarial jobs, was married and had four children. A keen curler and promising golfer, Ellie is involved in many Syncrude social functions. Ellie fulfills the secretarial and clerical duties of the Enviromental Affairs group ensuring that information flows smoothly within the group.

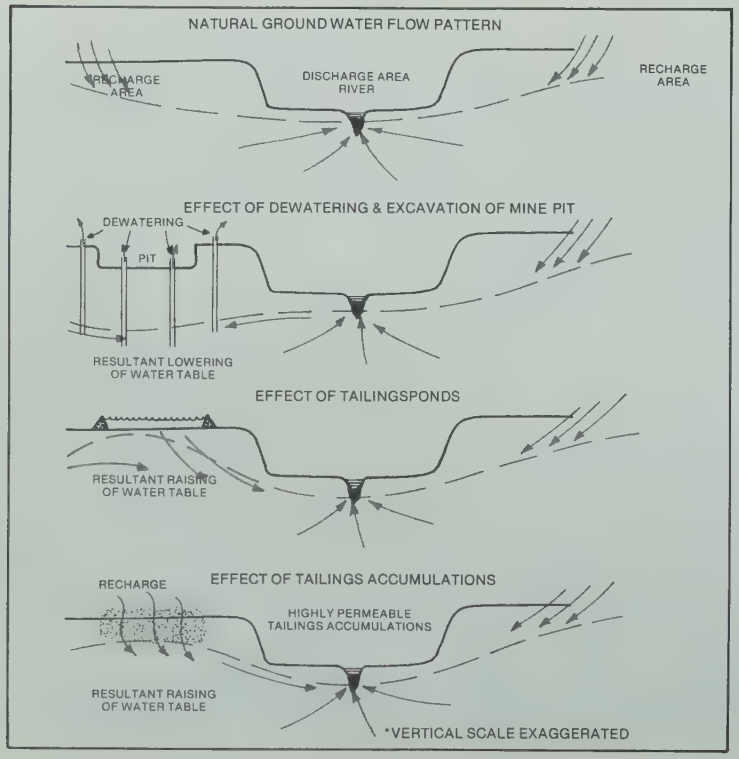
## How Will Syncrude's Operations Affect the Local Groundwater System?

The main aspects of Syncrude's operations that will affect the groundwater system are the dewatering and excavation of the mining pit, establishment of retention ponds, and the elevated accumulations of sand tailings when operations are completed.

Dewatering and excavation of the mining pit may affect the quantity of the groundwater naturally entering the Athabasca River by altering the groundwater flow pattern and the level of the water table. Because the pit will act as a groundwater discharge area, natural discharge into the Athabasca River could be reduced. Dewatering of the pit will be necessary to permit safe efficient mining operations. This will result in a local drawdown of the water table further altering the natural groundwater flow pattern.

Tailing ponds may act to raise the level of the water table by acting as a man-made recharge area and possibly altering the natural flow pattern and amount of groundwater flow. However the presence of fine clay particles in the water phase may seal the aquifers thus possibly offsetting the recharge features.

The bitumen extraction process and tailings replacement will result in an increased volume of the tailings, and returning these to the mine pit will result in a permanently higher surface. The water table will tend to reflect the altered topography. Because replaced sand tailings will likely be highly permeable, they will act as recharge areas.




## Environmental Research Monographs

Two new monographs, "The Beaver Creek Site: A Prehistoric Stone Quarry on Syncrude Lease #22" and "Revegetation: Species Selection, An Initial Report" were tabled in the Alberta Legislature by Hon. W.J. Yurko January 29, 1975 and are now available. The former is discussed in the front page article of this issue.

"Revegetation: Species Selection, An Initial Report" focuses on the selection of those plant species which are most likely to be useful in a successful revegetation program in the tar sands area. A successful program, as defined by Syncrude, is one which produces a stable, self-supporting plant community capable of supporting a biotic population similar to that which utilized the area prior to disturbance. For this reason, native and naturalized species are to be used to the greatest extent possible.

Surveys of the natural vegetation of the area and of artificially and naturally revegetated areas give an initial indication of possibly useful species. Preliminary growth chamber studies carried out on several species in various soil types have indicated species to be studied further, as well as showing that the selection process may have to go as far as selecting between ecotypes of a single species (that is, individuals of a species adapted to a particular environment).

The Syncrude Environmental Affairs Group publishes these documents in an effort to make its research findings public knowledge.

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# SYNCRUDE: ENVIRONMENT

*Jackpine [Pinus banksiana] covered roughly 60% of Lease 17 before clearing activities began.*

## What impact will Syncrude have on the Environment?

At Syncrude's Environmental Affairs Department we receive many different questions about the problems we face, but they all boil down to "What impact will Syncrude have on the environment?" In this issue of Syncrude: Environment we will try to answer these most commonly-asked questions as clearly as we can, keeping in mind that research into the Athabasca Tar Sands is still proceeding and that our answers are often modified as new information comes in. However, here are the answers as we have them in September 1976.

## How will Syncrude be getting oil from the tar sands?

Because the tar sand lies so close to the surface on Lease 17 Syncrude will be able to operate an open pit mine with a maximum depth of about 60 m (200 ft). The overburden (non-oilbearing surface material) will be stripped off, and the tar sand mined by four giant draglines. Each dragline will remove material with a bucket which, at 60$m^3$ (80 cubic yards) would be about the size of a two-car garage. The tar sand will then be conveyed to the processing area where the bitumen will be extracted and upgraded to synthetic crude oil for transportation to Edmonton. The leftover sand and process water, known collectively as tailings, will be directed into a dyked tailings pond, whose surface area will eventually reach 30 $km^2$ (12 sq mi). None of the water exposed to the tar sand extraction or upgrading processes will be discharged into the local streams or the Athabasca River.

Within the first decade there will be adequate space within the open pit mine to allow the company to begin placing tailings sand and stored muskeg back in the mined-out areas. Eventually the entire pit will be refilled. Syncrude plans an ongoing revegetation program during which the middle portion of this sand-filled area will be seeded even while the edges are still being mined. (We will say more about revegetation later in this bulletin.) Mining will proceed for 25 years.

## Why did Syncrude choose an open pit mine? Wouldn't it be easier to pump the oil out, or mine it underground?

The raw bitumen in the tar sands can't be pumped out directly as in a conventional oil well. It would have to be thinned first by breaking down the large molecules, which make it viscous, into smaller ones. At the time the plant was designed, reliable techniques had not been developed for this "in situ" (in place) separation of bitumen from tar sand, while the technology used by Syncrude had already been proven elsewhere on an operating scale. Furthermore, since Syncrude's lease has relatively little overburden, it will be comparatively simple to remove the tar sand using surface mining techniques.

Underground mining (as in coal mines) is not practical because the rate at which tar sand could be removed would be too low to maintain an economically viable processing plant.

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## What effect has Syncrude had so far on the land surface?

Since surface mining is a basic part of our operation, it will be necessary to progressively remove the trees which are growing on the mine, plant and tailings pond sites, a total area of about 60 $km^2$ (25 sq mi). Enough land for 12 years of mining has been cleared to date. Muskeg cleared from the site is being stored in piles for use in our reclamation program. Trees that were suitable for commercial use have been made available to the native residents of Fort McKay; the rest have been collected and burned on the site. It has also been necessary to divert the local streams and creeks away from the mine and tailings pond in order to permit the proper and safe operation of the project.

## What exactly is happening to the local streams?

Beaver Creek flowed through the middle of the mine and tailings pond sites until 1975 when it was dammed and diverted into Ruth Lake and thence to Poplar Creek and the Athabasca River. A few other small creeks also flowed into the mine area but have been captured by an interception ditch (see map). Syncrude is re-routing the local surface water away from the site in order to keep the mine as dry as possible. As a result of this program water bodies which will be favourable to waterfowl and shorebirds have been created.

Water is necessary for the operation of the plant. This process water will be pumped up from a sedimentation basin beside the Athabasca River, but will be discharged from the plant into the tailings pond and recycled. At no time will Syncrude be drawing off more than 1.5% of the flow of the Athabasca River, and after year three of operations, recycled water will be used in the plant, vastly reducing the need for fresh water supplies.

A saline aquifer underlies the tar sand on Lease 17. The water occurs under pressure, which must be relieved by pumping before mining can safely proceed. This "mine depressurizing water" has been sent through the original Beaver Creek channel into the Athabasca under government controlled conditions, but in the future will be routed either into the tailings pond or into the Ruth Lake/Poplar Creek system. Studies have been underway for some time into the effects of saline mine water disposal methods on both the environment and the Syncrude plant processes.

## I have heard a lot about sulfur from Syncrude Polluting the air. What is your position on this matter?

The Alberta government will be permitting Syncrude to emit a maximum of 287 long tons of sulfur dioxide ($SO_2$) per day. $SO_2$ can become an environmental hazard when people, vegetation or animals are exposed to high concentrations for extended periods of time. We must therefore be confident that the ground level concentration (GLC) resulting from our $SO_2$ emissions will be within safe limits.

GLC is measured, usually in parts per million, (ppm) as an average over a time period. Alberta Department of the Environment regulations specify maximum average $SO_2$ concentrations of .20 ppm over one-half hour, .17 ppm over one hour and .06 ppm over 24 hours. These standards are strict (the Federal "one hour" limit is .34 ppm -- half as stringent as Alberta's) so complying with them implies a wide margin of safety.

The dominant feature of the Syncrude plant is the 183 m (600 ft) stack through which all of the plant's waste gases, including $SO_2$ will be emitted. The stack was designed with a GLC of .04 ppm as the "half hour" maximum under neutral atmospheric stability conditions. This low level was sought in order that future plant developments in the area would not combine to cause illegal or dangerous ground level concentrations. The most recent calculations predict compliance with Alberta's standards 99% of the time.

## What about those newspaper stories of "Acid Rain" and "Killer Fogs"?

Acidification of rain and snow has occurred in Scandinavia and fears had been expressed that this would occur as a result of Syncrude's sulfur emissions. The Alberta Department of the Environment commissioned Western Research and Development Ltd. to study the whole question of air pollution around the Athabasca Tar Sands. In

their report, dated March 1976, the consultants list the following points in what they admit is a preliminary assessment:

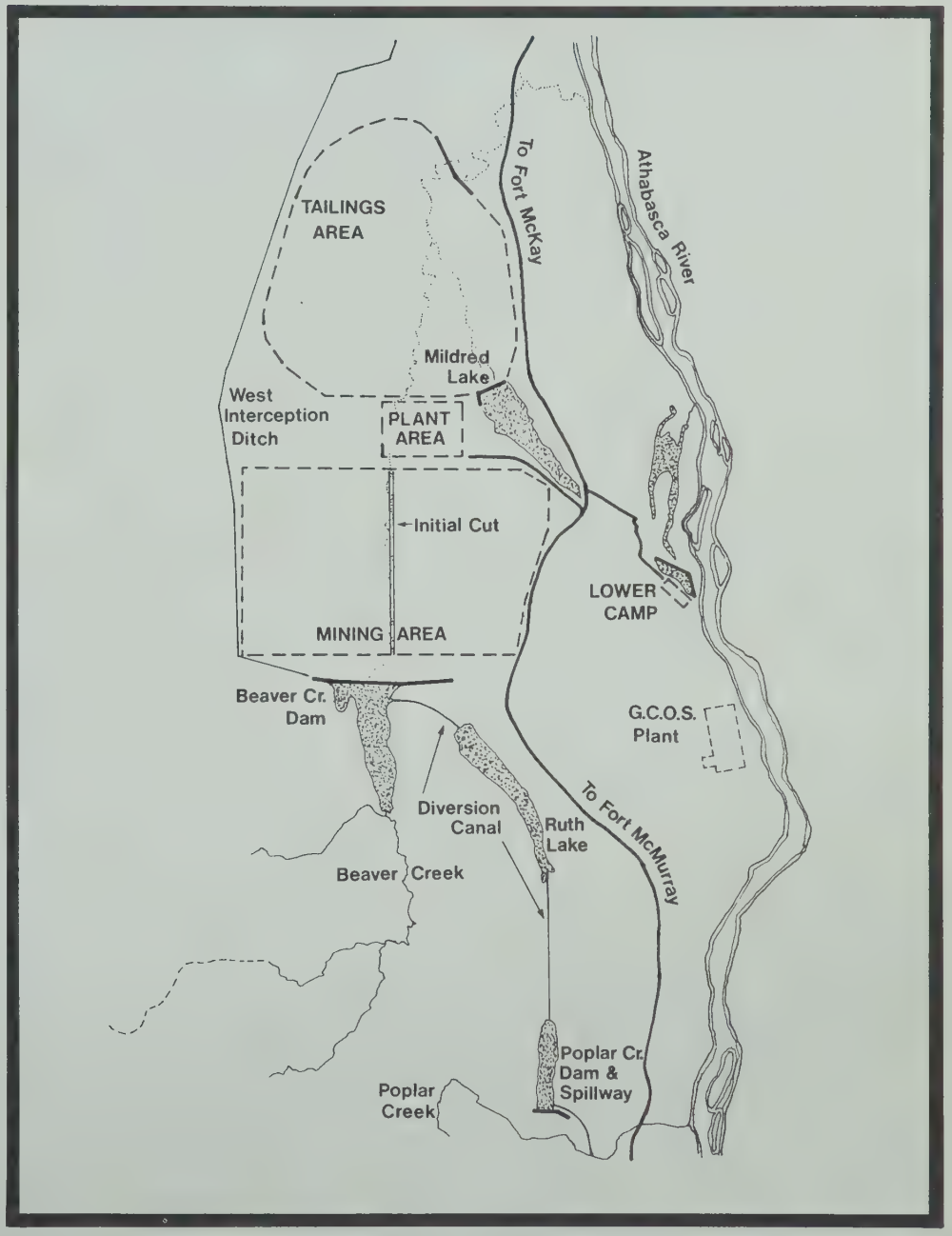
*"In the oil sands region the source of sulfur will be much smaller than in industrialized Europe. Air leaving the oil sands area will not be saturated with water to the degree that it would be were it to pass over the ocean, nor would it be involved in orographic [relief-caused] rain episodes. For these reasons it seems reasonable to assume that the acid rain problems encountered in Scandinavia will not occur in downwind areas of the oil sands." [WRD report p. 54]*

The same report also briefly discusses low temperature fogs, which are expected to be common in the winter months because of the amounts of warm water involved in the plant processes. The point had been raised that the $SO_2$ from the stack could mix with the fog and produce conditions analogous to London, England's "killer smogs" of 1952. Analysis of atmospheric data has indicated that when conditions are conducive to ice fog formation, the plume from the stack will tend to remain at a high altitude and not mix with the fog. As a result, according to WRD, the Syncrude plume "should have a negligible effect on ground level air quality" during ice fog episodes.

## What will the mine look like after Syncrude has finished operations?

Syncrude intends to fill the mine with the sand tailings left after the bitumen has been extracted. The surface of these tailings will be mulched, fertilized and seeded with a variety of plants in order to produce a self-sustaining and stable community. The company is currently undertaking research into the types of vegetation which will be most suitable for the area, and into the most effective methods of seed and fertilizer application.

The revegetation of the mine site will begin within the first decade of mining, but programs to revegetate other areas on Lease 17 have already started. Seed and fertilizer have been applied to the Poplar Creek spillway and parts of the west interceptor ditch. The outside faces of tailings dykes will also receive




*The Syncrude site, shown here, lies about 270 miles [430 km.] northeast of Edmonton, Alberta.*

seed and fertilizer before the mine site revegetation begins.

The tailings sand will be deposited in the centre of the mine pit first. As mining continues and more tailings are added the pile of sand will grow. When the central portion of the pit is full enough to be revegetated, new tailings piles will be started in the more recently mined out areas of the pit.

Syncrude's reclamation commitments are backed up by a performance bond deposited with the Alberta Government. The bond will amount to about $35 million over the life of the mine, and could be forfeited if reclamation is not satisfactory.

## You will be creating a tailings pond which will be larger than most of the local lakes. Will it be hazardous to birds?

The tailings pond will receive effluent containing chemicals and unrecoverable bitumen. The chemicals will not be present in concentrations toxic to birds (most can be found in similar concentrations in sea water) but bitumen floating on the surface poses a serious threat to birds. The effect of the bitumen is to reduce the insulating capabilities of the bird's feathers, resulting in an increased heart rate which usually causes death.

Because the Syncrude site lies near a major migration staging area (the Peace-Athabasca Delta, one hundred miles north) large numbers of waterfowl and shorebirds can be expected to either fly over the lease or use it for stopovers. Since the birds will be safe if they do not contact the bitumen, methods of reducing the portion of the pond covered with oil, combined with methods of deterring birds from the oily area, will reduce the hazard. Research by Syncrude into deterrent methods began some time ago.

One aspect of Syncrude's environmental studies was a three-year inventory of the birds and their preferred habitats on Lease 17. Consideration is being given to planned alteration of selected habitats, in order to reduce the attractiveness of the lease area to those birds most likely to use the tailings pond.

**SYNCRUDE: ENVIRONMENT**

**Syncrude:**

Environment is published to provide a continuing report on the environmental activities of the Syncrude Project, and to aid in opening a two-way line of communication with the public. It is distributed without charge to individuals and organizations concerned with the ecology of the tar sands region. For more information on Syncrude's environmental activities or to be included on the mailing list please send your request to:

**Syncrude: Environment**
**P.O. Box 5790**
**Edmonton, Alberta**
**T6G 4G3**

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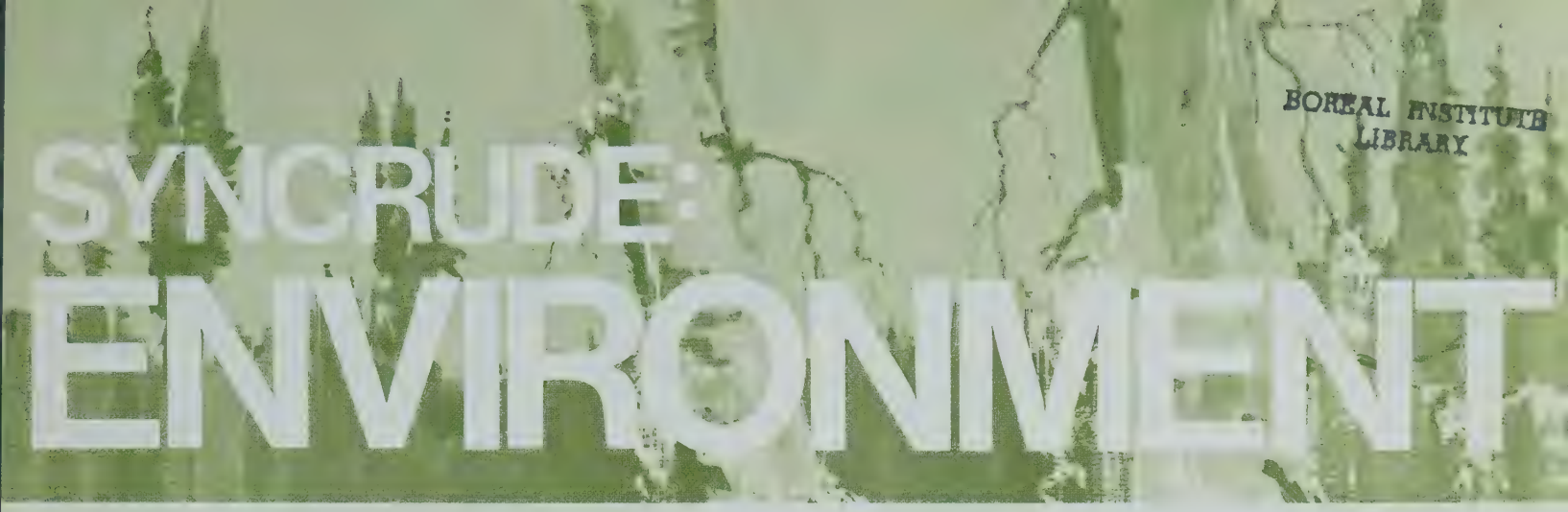


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# Oil Sands Environmental Study Group

During the summer of 1973 a field team conducted a survey of the tar sands area near Fort McMurray as a part of a study of the revegetation of disturbed, non-cultivated areas in Alberta being conducted by the Alberta Department of Agriculture.

Funding of the field team was provided by members of the Oil Sands Environmental Study Group, an organization of 19 tar sands operators and leaseholders formed to carry out environmental research in the area. In return for their support of the project, participating members of the O.S.E.S.G. will receive the results of the study as an aid in formulating their own reclamation plans.

The collection of such information is a basic part of the Group's program to evaluate the impact of tar sands developments in order to ensure that future projects are compatible with environmental requirements. Among the future studies being considered are a climatological-hydrological study, a groundwater mapping program, and a soil survey.

The Study Group was formed early in 1973 because of the belief that environmental problems associated with the tar sands development are sufficiently unique in type and scale to merit the consideration of such an organization. Operating co-operatively, with a comprehensive research plan to avoid duplication, the O.S.E.S.G. works closely with various provincial government departments concerned with environmental legislation. Research is financed by those member companies concerned with and benefiting from each individual program. An additional objective of the Group is to keep the public informed of development proposed by its members.

Membership of the Oil Sands Environmental Study Group includes most active leaseholders in the Athabasca area as follows:

Amerada Minerals Corporation of Canada Ltd.
Amoco Canada Petroleum Company Ltd.
Ashland Oil Canada Ltd.
Aquitaine Company of Canada Ltd.
BPOG Operations Ltd.
Can-Amera Export Refining Company Ltd.
Chevron Standard Limited
Great Canadian Oil Sands Limited
Home Oil Company
Hudson's Bay Oil & Gas Company Limited
Husky Oil Operations Ltd.
Pacific Petroleums Limited
Petrofina Canada Ltd.
Shell Canada Limited
Syncrude Canada Limited
Tenneco Oil & Minerals Ltd.
Texaco Exploration Canada Limited
Total Petroleum (North America) Ltd.
Union Oil Company of Canada Limited

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# Citizens' Forum

## Environmental Effects of the SYNCRUDE Project

Residents of Fort McMurray who were concerned about the impact of the Syncrude Project on the environment were given the opportunity to present their opinions and question the company's Environmental Affairs Group at a Citizens' Forum on the Environment held October 30 in the Alberta Vocational Centre.

The forum opened with a general overview of the subject presented by Syncrude personnel. Questions were then invited and answered. Special dialogue groups were formed specifically to discuss wildlife; the natural environment and mine reclamation; the working environment at the plant and in the town; the atmospheric environment; and future plans and environmental research.

About 60 people attended the forum but it was considered a success in spite of the low number because those present were knowledgeable and concerned. Their questions were relevant and they actively participated in discussion groups.

As a follow-up to the forum, six of the most pertinent questions asked were printed and answered in a single-sheet flyer which was distributed throughout the town as an insert in the Fort McMurray Courier. (Reprinted alongside.)
The open line radio show which followed this announcement was hosted by two of Syncrude's Environmental Affairs Group and gave residents a further opportunity to have their questions answered.

**1] How accurate is the information on which Syncrude is basing its environmental protection plans?**

**2] How will Syncrude restore the land?**

**3] What will be the results of the diversion of Beaver Creek?**

**4] How is Syncrude planning to compensate for the loss of the Beaver Creek campsite?**

**5] What will happen to the environment when additional plants are constructed?**

**6] What is the Oil Sands Environmental Study Group?**

These are some of the more far-reaching questions which were asked by Fort McMurray residents who attended the Syncrude-sponsored "Citizens' Forum on the Environment" at the Alberta Vocational Centre on October 30. There were a number of other queries, of course, but these are considered to be of the greatest general interest to the community as a whole. Because they affect everyone in the community, Syncrude feels that this information is due to all residents and is taking this opportunity to provide it.

**1] How accurate is the information on which Syncrude is basing its environmental protection plans?**
Information for ecological baseline data reports was obtained through studies by competent consulting biologists and ecologists. Information relating to hydrology and factors of the physical environment was compiled from studies by engineering firms engaged by Syncrude. Use of outside expertise eliminates many of the biases which might occur if this data had been generated "in-house". Considering the specific and limited objectives of these initial studies, we feel that the information is accurate and complete. We realize that much more work in the way of follow-up is necessary. Monitoring wildlife population and continuation of other on-going studies in soils and revegetation are presently being carried out. New information will be used to up-date and revise our planning to continue to take into consideration plants, animals, and the environment, as a total system.

**2] How will Syncrude restore the land?**
Even before a decision had been made to proceed with the project, Syncrude had developed a reclamation plan designed to leave both land and water areas within the project site at least as capable of supporting plant and animal life as they are at present.

The mechanical operations of reclamation will begin with the casting of overburden and reject materials back into the mine pit. As soon as it is feasible, tailings from the extraction plant will be discharged over top of the materials. Under present plans, this should begin to occur about five-and-a-half years after start-up when the pit will be approximately 4,500 feet wide and 14,000 feet long. As the residual solids and associated waters will occupy a volume up to 30 per cent greater than the space created by mining, the final elevation in the mine area could be 100 feet higher than the surrounding terrain.

The centre portion of the mine will be refilled by 1990. At the end of the mining operations, tailings will fill the entire pit, with the exception of two sections, one at either side. Only overburden and rejects will be placed in these. With the addition of perimeter dykes, these flanking areas could provide enough volume to accommodate the contents of the tailings pond.

Throughout the life of the 25-year project, reclamation of the mine-area will be continuous. The final result, to be accomplished within two years of the termination of the project, will be the establishment of a self-perpetuating and maintenance-free vegetation cover compatible with wildlife. These objectives can be realized with the use of existing technology and without dependence on subsequent tar sands plants. Our research program into methods of revegetating areas disturbed by the project or reclaimed after its completion is a continuing activity.

**3] What will be the results of the diversion of Beaver Creek?**
Because the proposed mining area lies on either side of and beneath the present water course, Beaver Creek will be diverted into Poplar Creek. This will affect the lower 12 miles of the creek, an area presently offering limited fishing and recreational opportunities. Fishing in Poplar Creek will likely improve, offsetting this loss. At present, inadequate water flow and culverts along the highway prevent grayling and other fish from using the upper reaches of Poplar Creek. The added water from the Beaver Creek diversion, plus replacement of the road culverts with a bridge, should bring additional fish into upper Poplar Creek.

There are 28 other streams, 17 of them larger than Beaver Creek, within a 50-mile radius of the Syncrude plant site. These have a total length of over 2,300 miles and eight of them are accessible by car. The alteration of Beaver Creek will obviously have little effect on the fishing/recreation value of the total tar sands area. Further facts about the Beaver Creek diversion are available from Syncrude in a pamphlet entitled: "How will the Syncrude Project affect the Lakes and Streams of Northeastern Alberta?"

**4] How is Syncrude planning to compensate for the loss of the Beaver Creek Campsite?**
The Beaver Creek campground will be eliminated by the diversion by Beaver Creek in late 1975. Syncrude recognizes an obligation to see created a replacement picnic and outdoor recreation area for McMurray residents and will soon commence studies to determine the best possible locations for alternative sites.

**5] What will happen to the environment when additional plants are constructed?**
Syncrude's development plan takes into consideration the air quality and water quality effects of its proposed plant, the existing plant and three additional plants in the tar sands area. Our specifications assume that all operating facilities of all plants will meet the provincial standards and therefore, environmental quality will be maintained. It is important to remember that the start-up of these plants will be timed so that the initial impact is minimal in such areas as water withdrawals from the Athabasca River. Syncrude and the other plant specifically proposed so far, will operate without the discharge of water into the Athabasca. Reclamation of land over the entire area likewise will be phased because various companies will be in different stages of development.

**6] What is the Oil Sand Environmental Study Group?**
The Oil Sands Environmental Study Group is an organization of nineteen tar sand lease holders and operators, who have combined in a cooperative environmental research effort. The group also cooperates with the government agencies in environmental research programs. It is currently supporting a revegetation study and proposing hydrological and climatological studies.

# Environmental Impact Assessment

On September 4, 1973, the Hon. W. J. Yurko, Alberta Minister of the Environment, was presented with a four-volume, 1200-page assessment of the environmental impact of the Syncrude Project.

This massive document, prepared during the project planning stage by Syncrude's Environmental Affairs Group reviews the impact of resource use on the environment and its relationship to economic decision making. It also proposes alternatives for technologically feasible methods of minimizing this impact. To provide an initial control point, the assessment details the structure and function of the project area ecosystem under natural conditions, unaffected by human action.

Volume I of the set reviews all existing and pertinent environmental data, analyzing and interpreting various documents, studies, applications and reports which have been prepared by or for Syncrude. The succeeding three volumes provide background information to supplement the first section.

Volume II details the sequence of events leading to the present design of the Syncrude Project, incorporating applications presented to various government departments from 1962 through 1973. Volume III contains supporting ecological and environmental research reports, including a habitat evaluation, a baseline survey of Beaver Creek, a migratory waterfowl report and air- and water-quality baseline information.

Volume IV is an accumulation of documents relating to studies completed in support of project engineering and management activities. Four major study areas are included: economic and social impact of the Syncrude project; water management planning; site reclamation and air-quality studies.

The impact assessment predicts benefits and losses to biophysical productivity resulting from project activity. It also indicates which levels of biological organization are analyzed, including the standards and methods used for measurement. A description of the monitoring program to determine which changes are the result of natural processes and which changes are caused by disturbances is also covered.

This is the first of three Environmental Impact Assessments which are required under the Land Surface Conservation and Reclamation Act. The other two will be produced by Syncrude's Environmental Affairs Group during the construction and operating stages.

# Environmental Affairs Group

As Environmental Co-ordinator, Jim Nalbach is in charge of Syncrude's day-to-day environmental research. A graduate in forestry from the University of Montana, he was employed from 1950 to 1966 by the United States Forest Service. Jim came to Alberta in 1966 as Extension Forester with the Department of Lands and Forests. In 1967, he was appointed Senior Wildlife Management Biologist, a position he held until 1969 when he was re-assigned to represent the Fish and Wildlife Division on the Land Use Assignment Committee of the provincial government.

In 1972, Jim left the government to join the staff of Renewable Resources Consulting Services. He served as principal consultant on a number of major projects, including environmental studies for Syncrude. In October, 1972, he was named to his present position with the company.

A former president of the Alberta Chapter of the Canadian Society of Wildlife and Fisheries Biologists, Jim is presently chairman of the Oil Sands Environmental Study Group.

**James T. Nalbach, Environmental Co-ordinator**

# Syncrude Canada Ltd.
# Environmental Policy Statement

Syncrude Canada Ltd. works with the conviction that human use of the environment need not be destructive. With careful planning, based upon good information, man-altered and natural ecosystems can exist in harmony. In order to accomplish this planning, Syncrude considers resource development from a total-systems point of view. This comprehensive approach corrects the frequent tendency to attempt resolution of problems on a single purpose basis. The total-systems analysis approach leads to a plan of operations using the best practicable technology, both in resource development and in environmental protection. An ecosystem approach to resource development, an integral part of our approach, implies an understanding of and respect for the potential of natural systems and the use of the economy of nature, wherever possible.

Through a comprehensive program of surveillance of the effects of our technology and careful application of that technology, we aim to prevent accidental damage to the environment. Total effects will be examined by professional ecologists and study results provided to public representatives.


**SYNCRUDE:**
**ENVIRONMENT**

SYNCRUDE: ENVIRONMENT is intended to provide a continuous report on the environmental activities of the Syncrude Project. It is distributed without charge to individuals and organizations concerned with the ecology of the tar sands region. To be included on the mailing list, send your request to:

**Syncrude: Environment**
**807 Baker Centre**
**10025 - 106 Street**
**EDMONTON, Alberta**
**T5J 1G4**

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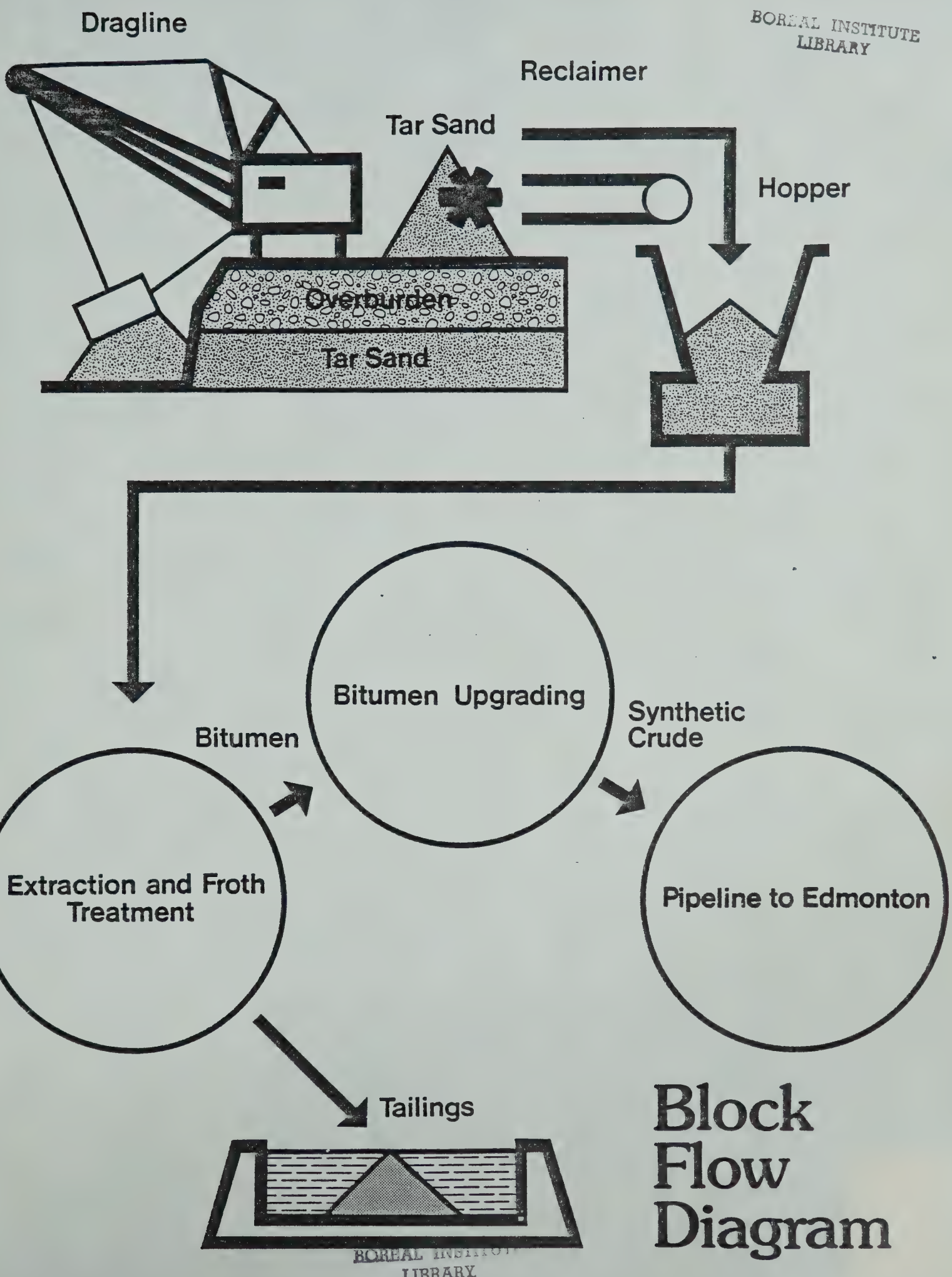


# Block Flow Diagram

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Information About the

# Athabasca Tar Sands

of Alberta

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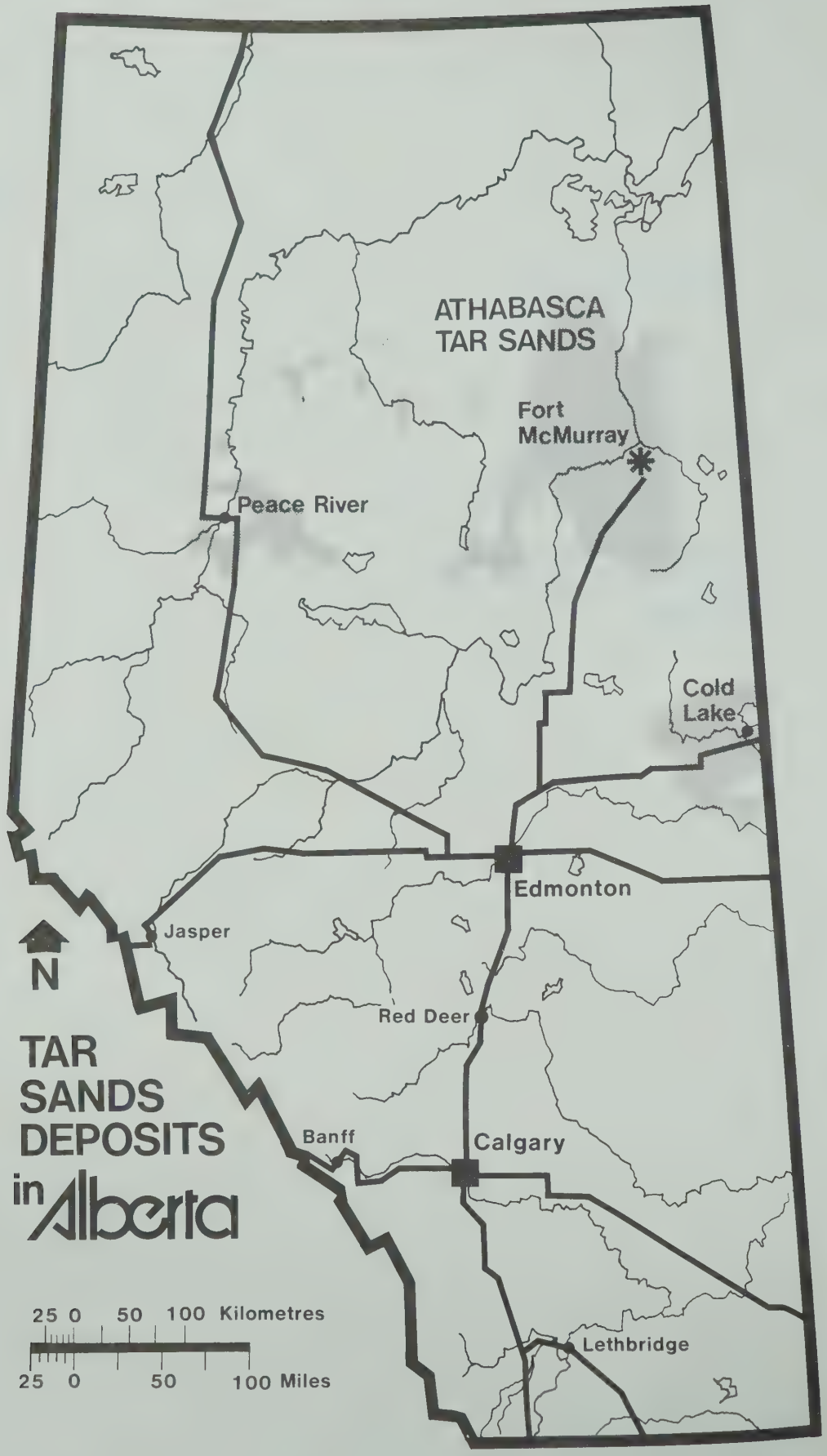
ATHABASCA
TAR SANDS
Fort
McMurray
Peace River
Cold
Lake
Edmonton
Jasper
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Red Deer
TAR
SANDS
DEPOSITS
in Alberta
Banff
Calgary
25 0 50 100 Kilometres
25 0 50 100 Miles
Lethbridge

# THE ALBERTA TAR SANDS

The mixture of sand, clay and heavy oil which is known as "tar sand" occurs in many areas throughout northern Alberta, but there are actually three major deposits. Two of these, in the vicinity of Cold Lake and Peace River, are very deep deposits 600 metres (2000 feet) and more below the ground. Here, the heavy oil must be heated in place or treated with chemicals to reduce its viscosity before it can be pumped to the surface by regular oil well drilling methods. This process is called "in situ" recovery.

The third and largest major body of tar sands, the Athabasca Tar Sands is located about 400 kilometres (250 miles) north-east of Edmonton. It covers an area of nearly 31,000 square kilometres (12,000 square miles) in a region surrounding the town of Fort McMurray. In places the tar sand is near enough to the surface to permit recovery by surface mining.

How much recoverable oil is there in all these deposits? At the present time there are, according to the Alberta Government, more than 26 billion barrels of oil that could be economically recovered by current mining methods. This would be enough to supply Canada for more than 50 years. Eventually it may be possible to mine as much as 86 billion barrels. In addition, another 200 billion barrels may someday be recoverable by "in situ" methods. Altogether, the long term production potential of the tar sands is close to 300 billion barrels of oil.

# THE ATHABASCA TAR SANDS & SYNCRUDE LEASE 17

# HISTORY

It was in 1875 that the Geological Survey of Canada realized that the tar sands justified a detailed geological study. In 1882, Robert Bell was sent to "examine more carefully than hitherto had been done the relations of the rocks of the river, especially with reference to the modes of occurrences of petroleum and asphalt." These studies and others confirmed that the tar sands, which are visible for 118 miles along the Athabasca River bank, had sufficient commercial potential to warrant further exploration and research.

Initially, the Athabasca Tar Sands were owned by the federal government, as were all of Alberta's natural resources. A memorandum of agreement was signed in December of 1929 between the federal and provincial governments to facilitate transfer of ownership. These rights of ownership were obtained by Alberta effective August 1, 1930. As early as 1919, when the Alberta Research Council was formed, the province had already taken steps toward finding a practical method of separating the sand and clay from the bitumen, as the oil is called. Many businessmen and drillers were also active in the area. Some drilled, hoping to find pools of liquid oil; one, R. C. Fitzsimmons, built a small commercial plant to actually extract the bitumen from the tar sand. In 1929, oil separated from the Athabasca Tar Sands by the mine branch of the federal government was used for road paving experiments in the City of Edmonton.

Early research established hot water extraction as the most promising method of commercial separation of the oil from the tar sands. In 1936, a developer named Max Ball experimented with a version of this process and started a company called Abasand Limited to explore the possibility of producing oil from the tar sand. The location of this plant was south of Fort McMurray where high grade tar sand exists. A diesel oil product resulted. It was pumped through a small pipeline to Waterways where it was loaded on barges and shipped north for use in mining camps on Lake Athabasca.

In 1941, when fuel oil supplies were threatened by the war in the Pacific, the federal government decided to investigate the feasibility of producing oil from the tar sands as a World War II emergency project. A committee was appointed to study the Abasand facilities. About this time Ball decided to rebuild the whole plant and it was dismantled for this purpose. Meanwhile, the threat to the west coast ceased to exist, but the government decided to go ahead with the investigation which included purchasing the Abasand facilities. The plant was reassembled but never really worked as well as it had before dismantling. A short time later (1945) the plant burned to the ground and was never rebuilt.

One of the original assignments of the Research Council of Alberta was to undertake a study of the Athabasca Tar Sands. Many studies and experiments followed through the years which, for the most part, were carried out under the direction of Dr. Karl Clark. As a climax to these many years of effort, the Alberta government built a 450-tonne (500-ton) per day extraction plant at Bitumount. During 1948 to 1949, this plant successfully demonstrated the technical feasibility of the hot water process; however, large-scale commercial design and ecomonic feasibility had yet to be demonstrated.

Although not commercially successful, these early efforts on the part of individuals, companies and governments added significantly to the store of technical knowledge which was relevant to subsequent attempts at commercial production of oil from the tar sands. Between 1950 and 1955, interested oil companies began to appreciate that early tar sands planning had been too limited in scope but when based on a sufficient scale of production and when conventional petroleum became in short supply, tar sands plants would likely become economically viable. This realization ushered in a new era of activity.

In the period following 1955, private industry once again assumed the preponderant role in tar sands

development research. Cities Service Athabasca Inc. (forerunner of Syncrude Canada Ltd.) built and operated, at Mildred Lake, 40 kilometres (25 miles) north of Fort McMurray, a 1000 barrel per day pilot plant which, at its peak, employed some 150 persons in experimental work on mining, materials handling and extraction. Following 1964, this work was moved to the company's research centre in southeast Edmonton. Other private companies built and operated both mining and in situ facilities to develop or test tar sand technology.

# GCOS PLANT

Great Canadian Oil Sands Limited began its plant construction in 1965 and first started to produce oil in September, 1967. The start up was understandably slow. The procedures and equipment were new and complicated. For the most part, the staff had to learn a completely new technology.

During the months of 1967 following September, synthetic crude production averaged approximately 1200 barrels per day. From then until 1970, production improved and upswings began to take place. In recent years, production has hit high levels. On certain occasions, extraction of bitumen has been in excess of 100,000 barrels per day and production of specification synthetic crude has been over 70,000 barrels per day; however, sustained production appears to be in the range of 55,000 to 60,000 barrels per day. The Oil and Gas Conservation Board, now known as the Energy Resources Conservation Board, estimated in 1964 that the GCOS lease contained 1,031,000,000 barrels of bitumen in good grade oil sand beds and that 630,000,000 barrels of this reserve could be recovered. GCOS, like Syncrude, is a mining operation. Mining in the extremely cold temperatures plus the abrasive conditions of the tar sands make it expensive, risky and highly complicated. Although much has been learned from GCOS since they first began producing synthetic crude, tar sand oil production is still not a simple problem and, even today, new and challenging difficulties are still arising.

# SYNCRUDE PROJECT

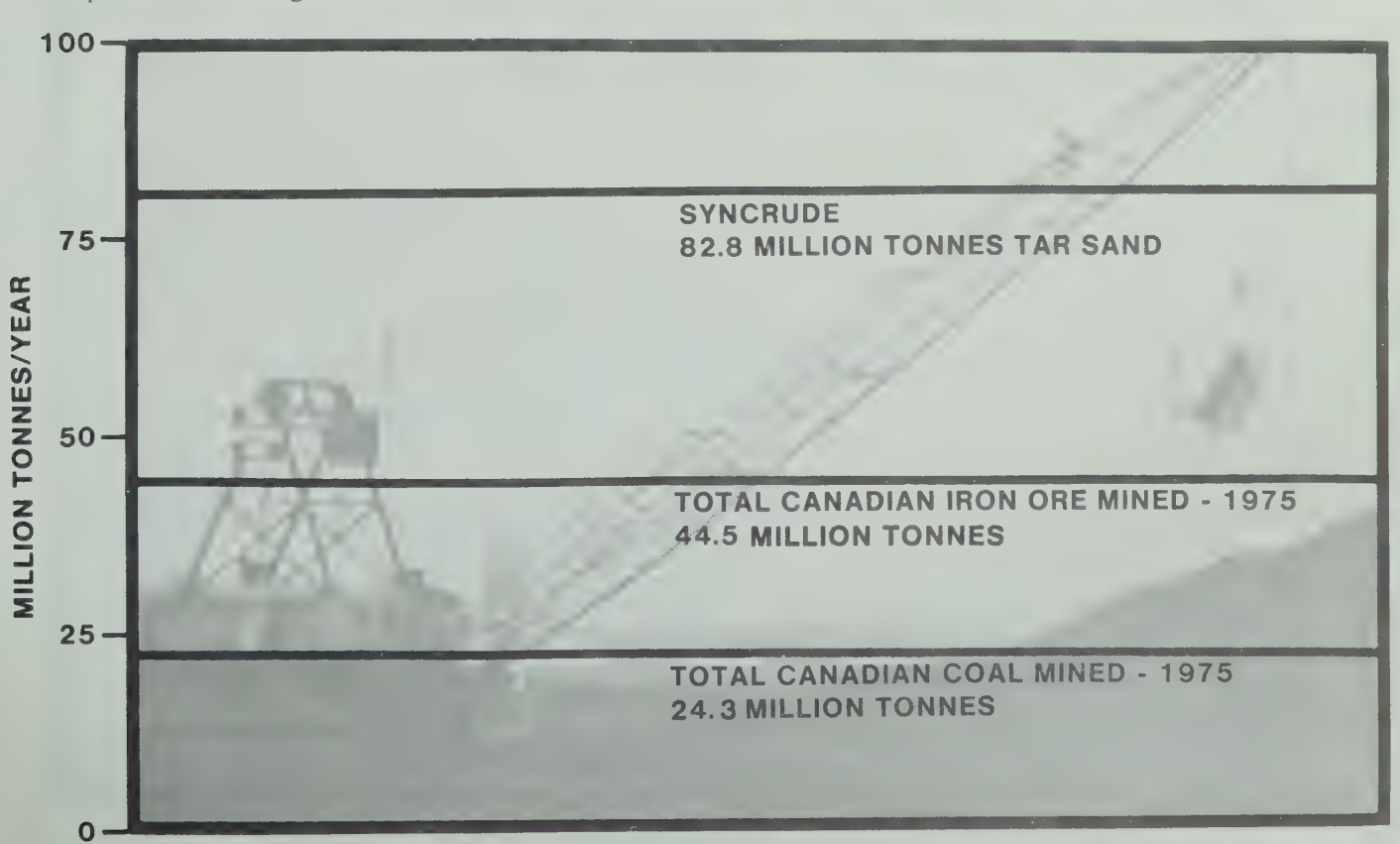
The Syncrude Athabasca Project began in the late 1950s. Syncrude first applied to the Alberta Oil and Gas Conservation Board in 1962 for permission to build a plant capable of producing 100,000 barrels per day of synthetic crude oil.* This was refused in 1962 because of the Alberta Government's policy of assuring conventional oil supplies of a sufficiently large market. Syncrude's second application in 1968 was again delayed due to perceived uncertainties related to the Prudhoe Bay, Alaska discoveries. In 1968, Syncrude received permission to proceed with plans for a plant and in 1971 the Alberta Government authorized this plant to produce 125,000 barrels of synthetic crude oil per day.

Today, Syncrude Canada Ltd. is owned by three oil companies and three governments. Each of the six participants has equity investment in the project and will receive a share of the final product according to its share of equity. Ownership of the company is divided as follows: Imperial Oil Limited 31.25%, Canada-Cities Service Limited 22%, Gulf Oil Canada Ltd. 16.75%, Government of Canada 15%, Government of Alberta 10% and the Government of Ontario 5%.

The responsibility of Syncrude is to construct and operate, on behalf of these participants, a facility to produce synthetic crude oil from the Athabasca Tar Sands.

The Syncrude Project will consist of three distinct but closely related operations: mining, extraction and upgrading.

* so called to point out that the raw oil found in tar sand bitumen requires physical and chemical alternations before it resembles most oil produced in conventional oil wells.

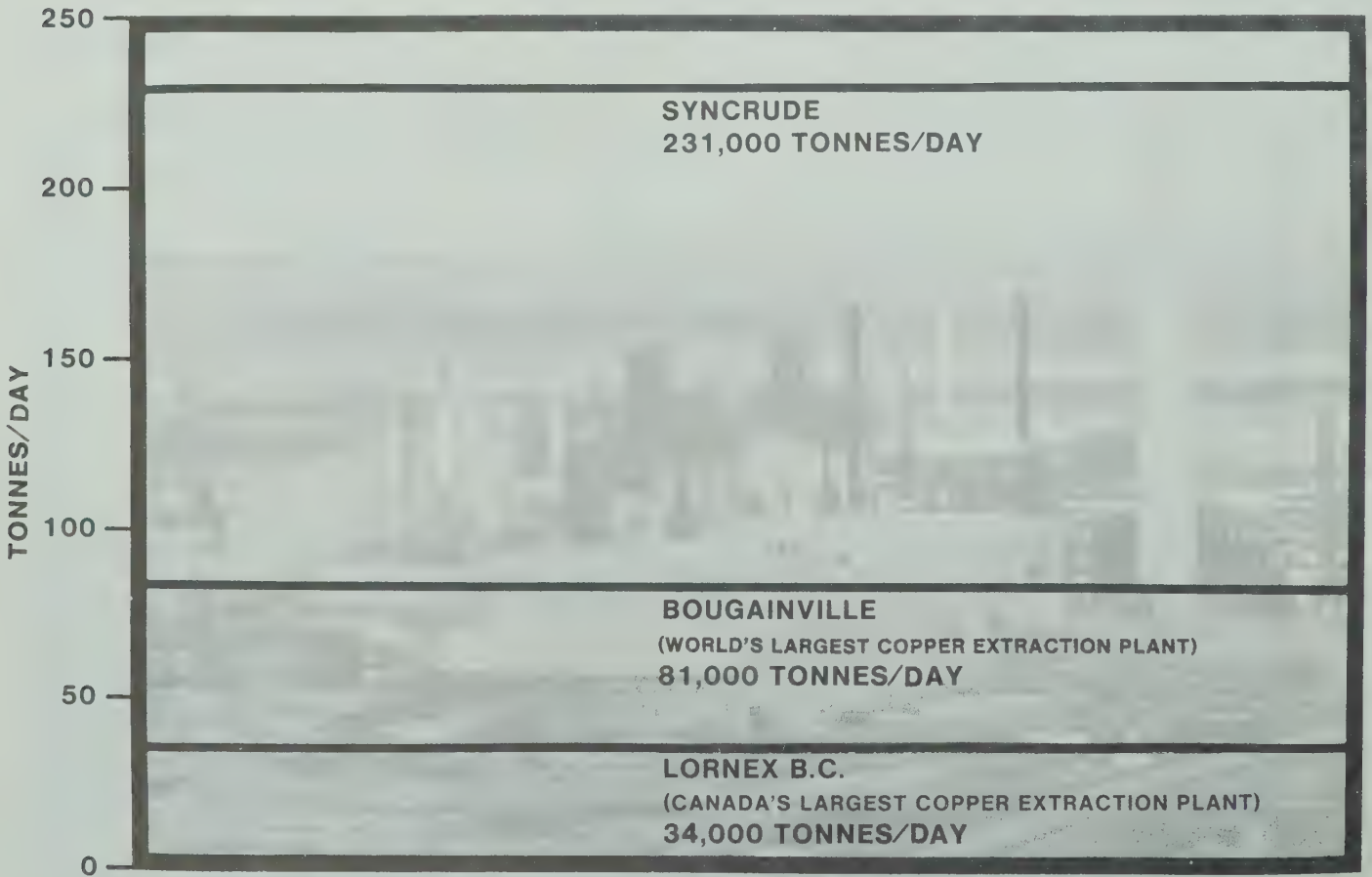



**MINING PRODUCTION**
**(MILLION TONNES/YEAR)**

The mining operation has two phases. The first is the removal of the overburden, the surface layer of muskeg and lean or oil-poor sand which lies on top of the tar sands. This will be done with large draglines equipped with buckets capable of holding 65 to 73 cubic metres (80 to 90 cubic yards) of material. The same draglines are used to mine the tar sand once it is exposed. Following the initial opening of the mine and after sufficient tar sand has been evacuated to expose the underlying shale, the overburden will be cast directly into the mined-out area. This is the first step in land reclamation.

Following mining of the tar sand, it will be loaded onto a conveyor belt system which will deliver it to the extraction plant. Here it will be mixed with hot water and steam to form an air-saturated slurry. This slurry is pumped into extraction cells where aerated bitumen (as raw tar sands oil is called), which rises to the top in the form of a water-and solids-laden froth, will be skimmed off. The bitumen froth is then treated to remove remaining water and solids and is then fed to the primary conversion units in the initial upgrading step.

During upgrading, the bitumen is "cracked" and separated into two streams: naphtha and gas oil. Each stream will be individually scrubbed to remove sulphur and treated with hydrogen. When blended together, these two streams will result in low-sulphur specification synthetic crude oil which will be piped to Edmonton for refining and subsequent transportation to markets.




**MINERAL EXTRACTION**
(TONNES OF ORE PROCESSED)

Auxiliary operations to the Syncrude Project entail a utilities plant to supply the project with steam and electrical power and a pipeline from the plant site's tankage farm to Edmonton.

The Syncrude Project is located on Lease 17 in the Athabasca Tar Sands. It is 40 kilometres (25 miles) north of Fort McMurray. Preparation of the project site commenced in the spring of 1974. It will take about five years to complete construction of the plant and the target for production of the first synthetic crude oil is early 1978. Commercial production is planned to begin at a rate of 52,000 barrels per day in 1978 and doubling during 1979. Thereafter, process debottlenecking is planned to reach the government approved 125,000 barrels of synthetic crude oil production daily.

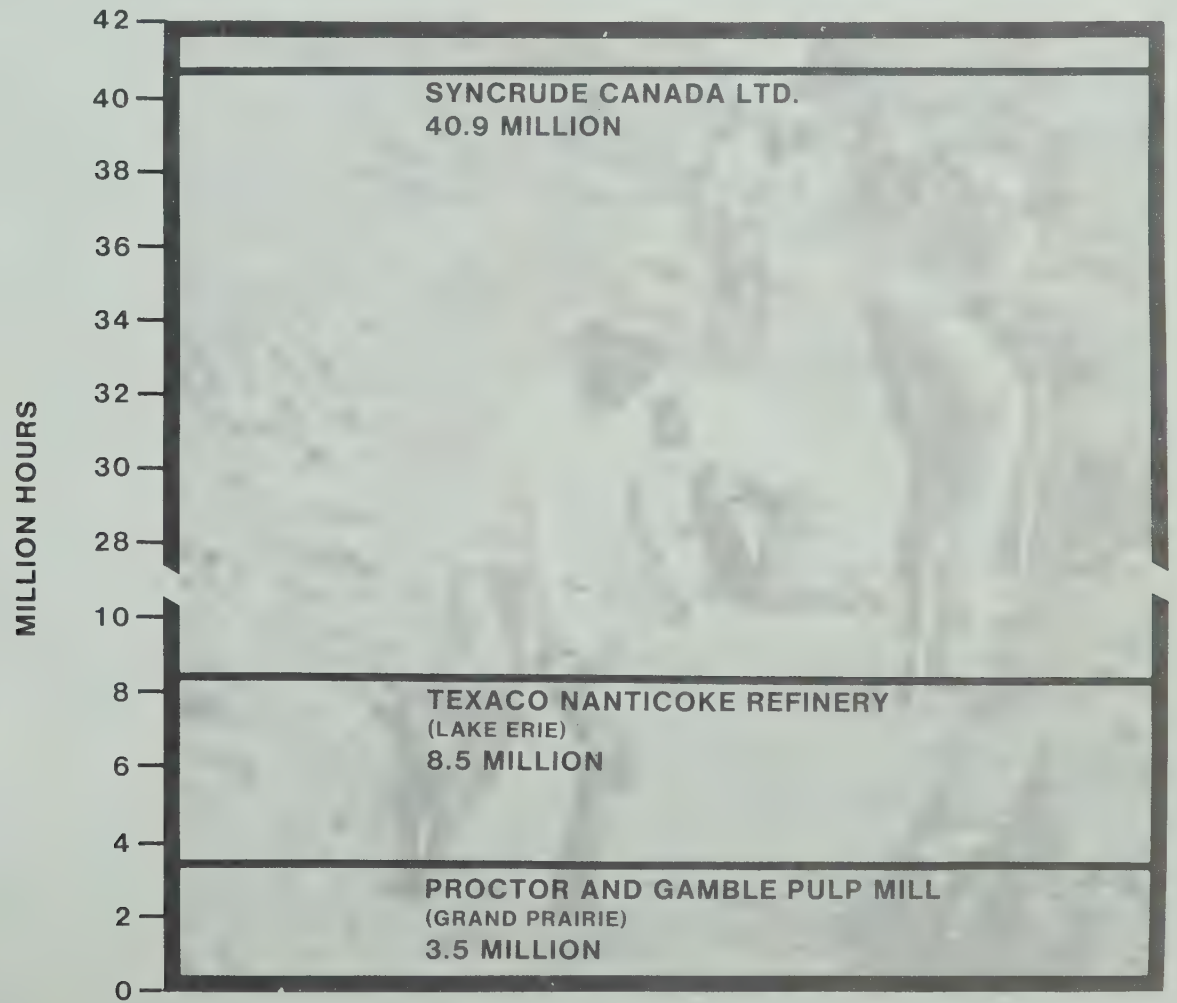
Over the 25-year life of the project, Syncrude expects to produce more than one billion barrels of synthetic crude oil from its lease.

Production will be from a mine site totalling about 28.5 square kilometres (7000 acres) in size. This mining site represents about one per cent of the area underlain by mineable tar sands in northeastern Alberta.

## BENEFITS OF THE SYNCRUDE PROJECT

The largest industrial facility ever built in Alberta, the production plant will cost an estimated $2 billion. Out of the total amount spent on the project, it is estimated that 70 per cent or more will be spent in Canada on materials, payrolls, equipment, engineering and consulting services. More than 65 per cent of the project is being designed in Canada by Canadian engineers employed by Syncrude or its contractors and subcontractors.

Construction of the plant will require a peak work force of close to 7,000 construction workers in 1976 and 1977. During construction, about 10,000 persons will be directly employed across Canada in work related to the Syncrude Project. The operation of the plant will be directly responsible for approximately 3,000 permanent new jobs in Fort McMurray and Edmonton and indirectly for 7,000 to 8,000 permanent new jobs in the Canadian economy.




**MAN-HOURS REQUIRED**
for Field Construction of Project, including Utility Plant

The Syncrude Project offers a major opportunity for Canadian engineers, consultants, researchers, and people in various petroleum technologies to gain expertise and experience in the brand-new technologies related to the tar sands. This know-how will remain in Canada, available for future tar sands developments long after the Syncrude project is complete. Interested white and native residents of northeastern Alberta, many of whom are unskilled and seasonably unemployed at present, are being provided with an opportunity for training and employment during the project's construction and operation.

Synthetic crude oil from the Syncrude Project will help offset the declining amount of conventional crude which will be produced in Alberta.

The province of Alberta stands to benefit in a number of other ways as well. In addition to its 10 per cent equity interest, the province has an option, through the Alberta Energy Company, to acquire a further 20 per cent of the equity after start-up. Loans from the Alberta government to Canada-Cities Service and Gulf Oil Canada of $100 million each are in the form of debentures convertible to equity. Should all these options be exercised, the province of Alberta would then own 36 per cent of the project and receive 36 per cent of the oil produced.

Under the terms of the original agreement, Alberta also receives 50 per cent of deemed profits in lieu of conventional royalties which normally accrue to the province. These are calculated by deducting the cost of production from the value of the oil produced. As an alternative, should sufficient profits not materialize, the province has the right to change to a straight royalty of 7½ per cent of the actual synthetic crude oil produced by the plant.

It is estimated that 70 per cent of the capital costs of the project ($1.6 billion) is being spent in Alberta and over $1.1 billion is direct income to Alberta wage earners. Over $500 million is being expended in Alberta on the purchase of materials and equipment.

# ENVIRONMENTAL PROTECTION

Can a company drastically alter 77 km2 of boreal forest without permanently damaging the environment? The potential damage resulting from any surface mining operation is enormous. Because of this, Syncrude has had studies underway since 1962——studies which will minimize environmental disruption by providing a thorough understanding of the boreal forest ecology. Since very little research had been published over the years, Syncrude was forced to start from scratch with "baseline" studies, which described the natural, undisturbed ecosystems of Lease 17. Today these studies provide a foundation of knowledge upon which impact assessments and operating procedures can be based.

Before the Syncrude Project got rolling the company committed itself to provide a three phase Environmental Impact Assessment. The first phase, submitted to Alberta Environment in 1973, was a predictive document which brought together the engineering specifications and environmental knowledge that had been gathered to that time. The two remaining documents will describe the effects of construction and of plant operation, respectively, and will be reportive rather than predictive.

Syncrude has adopted the policy of being open and frank about its environmental activities. This policy is a greater incentive for environmental responsibility within the company. A wealth of information has been published by Syncrude, including a number of scientific research monographs, which are listed in the "Reference" section which follows.

Syncrude has made copies of these monographs available in every public library in Alberta, in many school libraries, and in almost every university library in Canada. In addition, the 1973 Environmental Impact Assessment, and Site Development and Reclamation Plan, also dated 1973, were tabled in the Alberta Legislature and are public documents.

Environmental research can be a never-ending occupation. As an ecosystem is studied in greater depth, complexities are revealed which were not even imagined at first glance. Syncrude's ever-increasing environmental knowledge is used in a continuous process to update and modify plants for the development of Lease 17.

An undertaking the size of the Syncrude Project cannot avoid disturbing the boreal forest during construction and operation. But careful advanced planning and a watchful eye while work is in progress can minimize the disturbance. The project was designed with protection of the environment in mind, and the lasting effect of the Syncrude operation on the Athabasca Tar Sands region is expected to be minimal.

For example, about 11% of the sulphur naturally found in the raw bitumen will be emitted to the atmosphere in the form of sulphur dioxide through a 183 m (600 foot) tall stack. Detailed mathematical studies are now underway to predict the behavior of the stack's plume under each of the atmospheric conditions which occur over Lease 17. Alberta Environment had a say in the design of the stack, which is intended to limit ground level concentrations of sulphur dioxide to a quantity which would permit the establishment of four other tar sands plants without violating Alberta's stringent air pollution regulations.

A reclamation scheme has been devised for the mine pit, which will be refilled with overburden and processed sand, then contoured and revegetated. Plans for this multimillion dollar undertaking are being adjusted and improved, using the results of small pilot projects in progress on both Lease 17 and Great Canadian Oil Sands property. The company is confident that once the mining is completed the environment of Lease 17 can be returned to a productive, self-supporting state.

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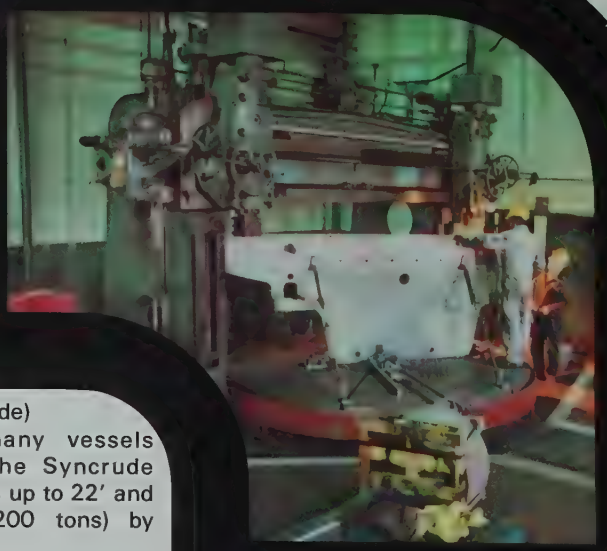


(left side)
One of the many vessels fabricated for the Syncrude Project (diameters up to 22' and weighing over 200 tons) by CESSCO.

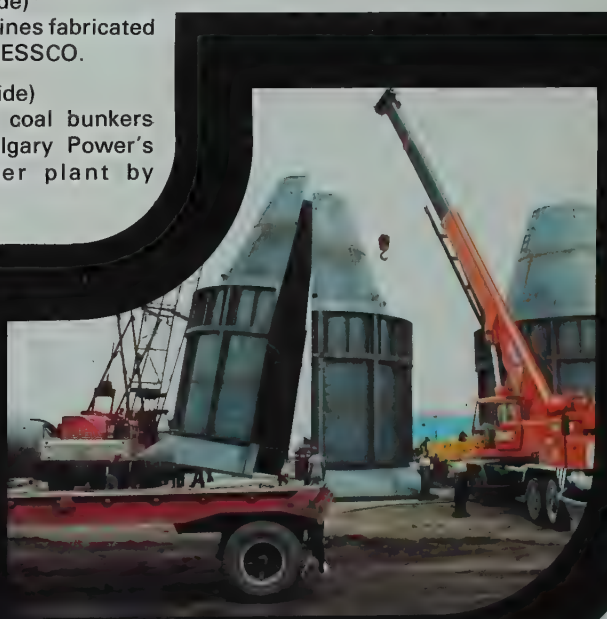
(right side)
To meet Alberta's growing demands CESSCO has installed the largest boring mill in the province (12'-0" dia.)

# CESSCO

## Manufacturing for Canada's Growing Industry

(left side)
10' diameter gas lines fabricated for Syncrude by CESSCO.

(right side)
25'x27'x50' high coal bunkers fabricated for Calgary Power's Sundance power plant by CESSCO.



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## INTRODUCTION

# SO THIS IS OIL

*by*
***the Editor***

As a finite resource, mineral oil, petroleum, known to man for thousands of years and in universal use for more than a century, has taken on a new significance, and its exploitation as a resource, its use and its conservation will remain a major pre-occupation with mankind for many years to come.

Realization has come to us — suddenly for the most part despite warnings sounded by petroleum engineers but unheeded in the confusion of chaotic profligacy — that oil is a dwindling asset, that world-wide the discovery of new commercially workable reserves of it is no longer likely to keep abreast with world demand and that its continued availability no longer therefore stretches into some indefinable future but can be measured only in terms of a few short decades.

With this awakening has come an increased awareness of the massive part petroleum plays in the world's everyday life and some recognition of the stark reality that without it, or without an equally good substitute — a number of substitutes, in fact, if the versatility of oil is to be matched — civilization as we know it is at an end and life on this planet can be perpetuated only in near-primitive conditions.

Nowhere is this awareness becoming more acute than in Canada where so much attention is being focussed on the development of the potentially rich oil sands, and where GCOS as pioneers, and now the giant Syncrude plant, loom so large on the horizon.

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On the morning of Sunday, 28th August 1859, one Edwin Drake struck oil in the first oilwell ever drilled. It was in America — at Titusville, Penn.

The web of drama and romance that has since been woven around this event has identified it with the beginning of the world oil industry of today; but in fact if honor is to be apportioned among petroleum pioneers, most of the laurels should go to a Scotsman, James Young who, in October 1850, patented a process for the extraction of mineral oil from coal and subsequently established a plant for the production of petroleum from underground strata of oil shales at Bathgate, between Edinburgh and Glasgow in Scotland — a local industry that continued until the 1960s.

Wherever one's loyalties may lie among the pioneers, however, these were the beginnings, in the 1850s, of the commercial exploitation of natural petroleum resources on a big scale.

Oil was not unknown, of course, before that time. It had been in use for more than 5,000 years. Seepages of oil occur in several parts of the world — it appears on the surface of the ground as a sticky, bituminous substance — and from earliest recorded time man has found uses for it, such as in the caulking of his primitive boats and as bonding material in building, examples of which are still to be found at the Babylon site. Still to be seen, too, is the "burning fiery furnace", reputedly the scene of Shadrach's, Meshach's and Abednego's ordeal, which is hard by the Kirkuk oilfield in Northern Iraq, and which, except when it was doused for security reasons during the second world war, has burned with irradescent, fairy-like flames since time immemorial.

---

It is often said, and with every truth, that the world of today turns on oil. Certain it is that oil turns infinitely more wheels than any other fuel — and even other fuels depend for their efficient manufacture and function upon oil products. But it does very much more than turn wheels. Petroleum products enter into practically every facet of our everyday lives, and even those of our common needs that have no connection with oil need it to bring them to us. From the time we look at the clock on waking in the morning — a clock that has at least one plastic, or hydro-carbon, component — to the time at night when we take off our shoes, soled, if not made entirely, with synthetic rubber or synthetic leather, one or other of all the petroleum derivatives is serving us all the time. To associate petroleum only with transportation and space heating, which is still a popular misconception when we talk of dwindling reserves, is to perpetuate a delusion.

It is misleading to generalize, particularly in the light of our substantial reserves of coal which, with its hydro-carbon derivatives, can understudy petroleum in so many roles; but, taken by itself, the exhaustion of commercially workable oil resources would not only empty our roads, air space and seaways and stop our industries, but would deny our factories, homes and shops most of their essential components, fitments and commodities.

And it has to be borne in mind that the faster we use up one resource the heavier and more exhaustive our demand becomes on another, quite apart from the time factor, measured in terms of decades, involved in the development of a substitute resource — or, indeed, several substitute resources.

*As a reflection on all this, one conclusion is immediately apparent. Conceivably, in the short span of two centuries — from his first oilwell to, arbitrarily, the mid-21st Century — Man is using up a valuable resource that took Nature hundreds of millions of years to evolve.*

---

What is this stuff we call oil?

Natural petroleum lies in porous rocks deep below ground and in seepages on the surface; and to understand how it was formed and how it comes to be there today we must first know something about the earth on which we live.

This planet of ours is perhaps some 4,000,000,000 years old, and during the whole of this almost inconceivably long time its surface has been constantly changing. Where today there is sea, millions of years ago there was land; and where today there is land, seas rolled in the remote past.

We learn something about these changes by studying what is still happening today. The stuff of which this earth is made is rock, and rocks are slowly being changed. They are slowly but relentlessly being worked upon by the weather. Some are worn away by winds carrying dust; some are cracked and broken by frost and ice; those along the coastlines are eroded by the constant movement of the waves and by the pounding of heavy seas; inland, streams and rivers cut their way through them and even, in time, through mountains. And rocks that stand clear of the paths of rivers are worn away by rain.

All the natural elements, heat and cold, wind, water and time, all working together, destroy mountains; and in the end all rocks, hard and soft, are broken down into dust — loose rock particles that are carried away by rain and melting snows into the rivers. Slowly but surely, over millions of years, mountains are carried down to the sea.

## The McMurray geological formation

*Sedimentary rocks of Cretaceous age are widely distributed in the western, Arctic and offshore regions of Canada but apparently only in northern Alberta were geological conditions conducive to the widespread generation, migration and entrapment of heavy oil deposits in reservoirs of that age. Sedimentation processes during the Early Cretaceous in Western Canada were complex. The character of the sands and associated shales indicate that these were derived from two principal sources: (1) the Canadian Shield lying to the east, and (2) rising highlands of the Cordillera to the west. From these two widely separated source areas the sediments were transported by fluvial (stream) processes into the Alberta Basin, where they were deposited in a variety of continental deltaic and marine environments.*

*In the Athabasca area the Mannville strata are underlain by sediments of Devonian age which comprise the Waterways, Cooking Lake, Ireton and Grosmont formations.*

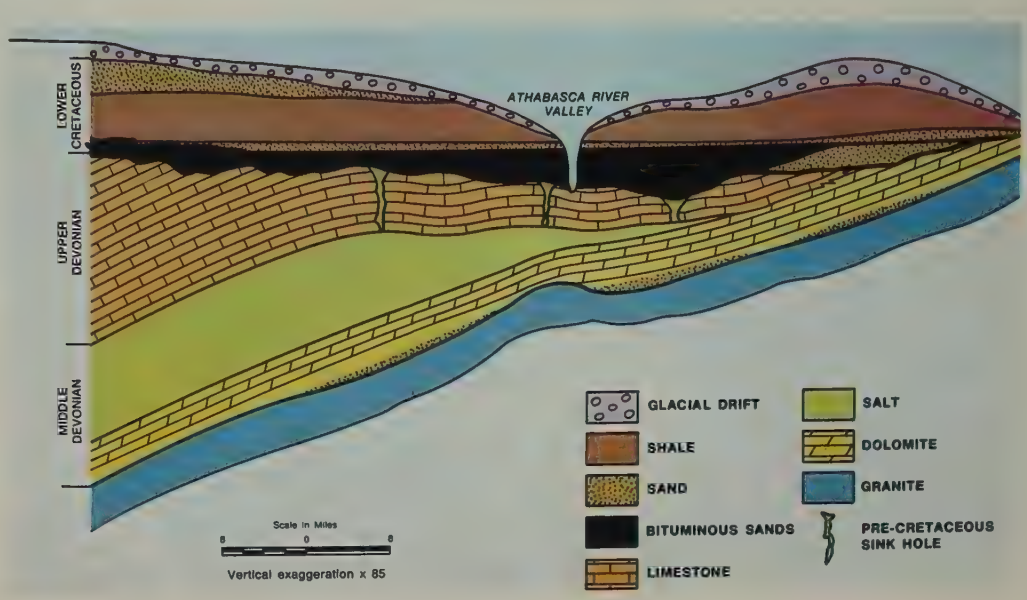
*The McMurray Formation unconformably overlies the Devonian rocks and is a combination of clastic materials having sources both in the Precambrian rocks east of the basin and in the igneous rocks of the Cassiar-Omineca and Nelson regions of central British Columbia. The majority of the crude bitumen reserves of this area are contained in the McMurray Formation and the Wabiskaw unit of the Clearwater Formation.*

*The McMurray Formation thickens in a northeasterly direction from its pinchout edge to a maximum of over 200 feet. In isolated locations its thickness reaches 275-300 feet.*

*The more continuous and widespread upper beds of the McMurray Formation consist mainly of horizontally bedded medium to very fine quartz sand with lenticular interbeds of silts and shales. There are occasional coal and plant remains.*

*The lower member of the McMurray occupies the deeper depressions of the Paleozoic surface and contains lenticular beds of coarse-grained, well rounded quartz sand with feldspar fragments and residual clay derived from the underlying limestone.*

*Oil and Natural Gas Resources of Canada 1976*
*Energy, Mines and Resources Canada*
*Published by Ministry of Supply and Services Canada*




*Diagrammatic representation reproduced by kind permission of Oilweek*

## INTRODUCTION

Because of the turbulence of the rivers most of the rock particles have no chance to settle, but enough of them sink to form mud on the river beds and to raise the levels of the rivers — and, in flood conditions, rock particles are deposited over wide stretches of land in the form of silt.

Once they have been brought down to the sea, the particles sink to the sea bed. They congeal together and, in the course of time and under the extreme pressure of the sea's weight and of constantly accumulating particles above them, they are compressed to re-form into rock.

But it is not only rock particles that have been involved in this ages-long process.

In certain ages, hundreds of millions of years ago, the seas were alive with multitudes of tiny creatures and with a profusion of water plants. And when the animals and vegetation died they sank to the bottom of the seas and became mixed with the rock particles. At the same time this mud was being pressurized slowly into rock, and in some way that has never been fully explained the tiny dead creatures and the decayed vegetation that had been trapped in the softer strata and buried under the bottom of the seas were changed by time, pressure and some kind of chemical action into oil — the crude mineral oil we know today.

Meanwhile, in all the millions of years that have followed, the earth's changes continued. Rocks were built up, layer upon layer, at the bottom of the seas and the oil was buried further and further down.

At this stage it is necessary to break off temporarily from the narrative and study certain different kinds of rock, for only in this way can we follow the sequence of events and understand what happened.

Among the commonest forms of rock are sandstone, limestone, shale and gypsum. These four can be divided into two categories, porous (such as gypsum) and non-porous (such as limestone). The porous rocks allow liquids and gases to pass through them; the non-porous rocks do not.

The enormous pressures bearing upon it caused the oil to move — upwards, outwards and downwards. In some parts of the world where all the layers of rock right up to the surface were porous the oil could move freely upwards until eventually it escaped to the surface of the ground and emerged as seepages. But in other places, when it seeped upwards through the rocks it reached a layer of non-porous rock and was stopped, the non-porous rock acting as a cap under which the oil was trapped.

This circumstance did not necessarily cause an accumulation of oil because, still under pressure, it moved outwards rather than upwards, spread itself thinly over vast areas and, to all intents and purposes, became dispersed.

But there were other circumstances. The earth's crust was constantly changing. Volcanoes and earthquakes are tangible signs of the enormous forces at work inside the earth even today; and, as well as these sudden movements, the earth's crust is always being subjected to slow but gigantic movements through massive expansion and contraction. The effect is to fold the rock layers. There are evidences of this all over the world. Strata have been twisted and bent, sometimes gradually, sometimes violently. And in some places great masses of rock, layer upon layer, have been folded into arches, or domes.

Under conditions like this, the oil — and, with it, the oil gas (and brine) which have survived with it in the porous rock — is trapped under a cap of non-porous rock of "dome" formation. The oil could no longer escape outwards; it has collected under the dome and has had to stay put.

In conventional oil production from drilled wells — "conventional" because it has been practised ever since Drake's and Young's time and because it has given us practically all our oil supplies to date — it is first necessary, by various scientific means that are not part of this story, to locate a dome and, by other scientific means, to assess the possibility of the presence of oil and its potential volume in commercial terms, and then to drill for it.

---

In tar sand production, which is what concrens us in this special supplement, we are back to seepages — circumstances in which the oil, formed far below ground, has been forced to the surface and has accumulated in pockets and inevitably become mixed with surface sediment.

The oil sands of north-eastern Alberta are actually a vast deposit of bitumen, a form of oil or hydrocarbon, which looks and smells more like thick tar and is mixed with sand and rock. In some areas it lies close to the surface where it can be removed by open-pit mining. In others — and this represents the bulk, perhaps 80 per cent, of the deposits — it lies deep underground and, in part at any rate, can be mined only by injecting heat to melt the bitumen so that it will flow to the surface.

The Athabasca Tar Sands in particular are one of the world's largest single energy resources in that they contain some 600 billion barrels of oil. About half of it is either currently recoverable or shows promise of being recoverable in the not too distant future. The part that now seems destined for earliest large-scale development is the 110 billion barrels of bitumen that lie sufficiently close to the surface to be eventually mined, and these shallow tar sand deposits could yield enough bitumen to provide 86 billion barrels of synthetic crude oil.

In other parts of the Tar Sand region there are also some 200 billion barrels of high-grade bitumen in deeper deposits which may one day be exploited by "in situ" production techniques, and in fact Imperial Oil have already declared their preparedness to proceed with a project, using methods which, in experiment, show good potential, given government approval and adequate financial backing.

The Tar Sands therefore represent an ultimate potential of more than 300 billion barrels of bitumen, which compares with the total proven North American reserves of 56 billion barrels of conventional crude oil.

The only comparable oil energy resources in North America are the oil shale deposits in the United States which may contain upwards of 600 billion barrels of petroleum, but no commercially proven method of extracting this oil has yet been demonstrated.

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The techniques of open-pit mining, which is what we are concerned with in the Syncrude operation, have been known since the 1930s, but they were not put into operation until the early 1970s when Great Canadian Oil Sands finally overcame the formidable technical and design problems that had plagued its processing since 1967.

The open-pit process is by no means simple. The sands have to be removed from the ground and sent by conveyor to the extraction plant where the bitumen is separated from the sands. The bitumen then has to be upgraded by the addition of hydrogen. The result is a synthetic oil of somewhat higher quality than that from a conventional oilwell.

An oil sands plant therefore basically comprises a huge open-pit mining operation that, in Syncrude's case, will move more material each year than all the rest of the Canadian mining industry put together; a power plant to provide heat and power; an extraction plant, and a refining or upgrading plant.

This massive operation — in terms of cost representing an expenditure of over $2 billion — together with all its political, social and environmental ramifications, is what this special Supplement is all about.


# The Syncrude Project is just over the horizon...

## ...But You'd Never Know It!

One of Canada's biggest and most vital industrial developments shrinks to insignificance when put into perspective with the thousands of square miles of unspoiled wilderness that make up north-eastern Alberta.

While men and machines work in one small portion of the landscape, vast areas of boreal forest, isolated lakes and fast flowing streams remain undisturbed.

Yet, from this small fraction of the frontier will one day come 125,000 barrels of crude oil daily to feed Canada's energy requirements.

*Alastair Gillespie*

# Canada's heavy oils and oil sands

*Written for Construction Alberta News by Alastair Gillespie, Federal Minister of Energy, Mines & Resources.*

In 1976, open pit mining resulted in 17.6 million barrels of synthetic crude oil from the bitumen of the Alberta oil sands. In addition about 14 million barrels of heavy oil were pumped from deposits in the sands of the Lloydminster area. This is barely a scratch on the surface of Canada's vast oil sands reserve which could produce a total extimated 200 billion barrels of synthetic crude under the right technological and economic conditions.

Our oil sands could be a major boon to Canada as a known source of domestic petroleum. Their development could be a decisive factor in our progress towards self-reliance in oil - a national goal established by the Government of Canada in 1976. Such a domestic source could go far in reducing our dependence on an unstable supply of expensive, imported oil.

The potential of the oil sands becomes all the more important when we consider the depletion of our conventional crude oil resources and the continuing decline in discovery of new conventional crude oil areas. According to the December 31, 1976 estimates, Canada has some 7.8 billion barrels of conventional crude oil and natural gas liquids in remaining proven reserves.

Conventional crude is oil that is usually available in marketable form with no upgrading required before shipment to refineries whereas the production of synthetic crude - the marketable product of the oil sands - involves an expensive and complex technology. This technology must be capable of drawing off and refining the tar-like bitumen found in the deposits at Athabasca, Cold Lake, Peace River and Wabasca and of obtaining and upgrading the molasses-like heavy oil at Lloydminister and similar fields. This means that convential oil sources are less expensive and more convenient to recover. However, while in 1966, 381 million barrels of new conventional crude oil were found, exploration in 1976 resulted in only 1.7 million barrels of new crude oil reserves - an amount that would meet Canada's need for only one day of consumption for that year. In fact, there has been no significant oil discovery in Canada since 1966.

Development of the oil sands will take time and money in terms of the new technology that will economically provide synthetic crude. It is obvious that Alberta's oil sands deposit are already becoming more economically attractive as an oil source. The high cost of bringing Arctic oil and gas to southern markets, the increasing price of imported oil and the growing expenses incurred by exploration firms as they reach out into remote frontier areas are all major factors that are slowly making the sands more economical.

But, while the supply and demand of the open market is very important to the development of the oil sands, we cannot afford to wait until these conditions alone allow the opening of the area. The technology must be developed now to assure us that the oil from the sands will be an available product when we need it in quantity and not still awaiting a technology that is in the development stage.

Under present technology and development only a small part of the total amount of oil in the oil sands is available. Major developments on the Athabasca oil sands are the open pit bitumen mining operations of the Great Canadian Oil Sands project and Syncrude, now about 60 per cent complete. Together, they will be able to produce about 64 million barrels of synthetic crude annually. Open pit mining is useful only for the portion of the oil sands that is within 150 feet of the surface - only about 10 per cent of the total reserve.

On the Lloydminster heavy oil field, various small producers have small recovery operations that pump heavy oil to the surface. In Canada, the product is used mostly for asphalt because upgrading facilities are not available. Thus markets for this oil are, at present, limited and some is exported to the United States where upgrading facilities do exist.

The balance of the reserve is attainable only through in situ techniques which are in the pilot stage and not yet economically feasible for large scale operations. These techniques release the oil from the sand particles and allow it to flow so it can be pooled and pumped to the surface. They are the only way of recovering the deeper reserve which, for the most part, occurs at from 300 to 2,600 feet below the surface.

Development of in situ techniques for broader use in oil sands areas will involve various incentives for the individual firms involved in such research.

Government agreement to a rise in the price of Canadian oil towards international levels has helped to some degree by releasing more funds for research and development.

Maintaining a continuous market to allow steady production of heavy oil while upgrading facilities are developed in Canada is another aspect. To help in this, the federal government has developed a new export licencing arrangement that distinguishes between the different types of crude oil and gives heavy oil special consideration with regards to allowable export quotas.

Most important, however, is the fact that the federal and Alberta governments have recently initiated new policy and technical discussions aimed at developing fiscal principles which will take into consideration the risks of private investors in oil sands development with its high costs and huge investment requirements. Such principles could reactivate interest in a third oil sands mining plant and speed up development of the heavy oils of the Cold Lake area and Lloydminster region. Initially, I believe that access to secure oil, even if the government has to provide special incentives for the production of that oil, is more important than a tax and royalty system which would nationally allocate significant revenues to governments but would provide no additional oil to the Canadian people.

The two governments have also embarked on a $96 million energy resource development program in addition to that already being funded by the Alberta Oil Sands Technology and Research Authority and industry. A federal-Saskatchewan agreement for joint funding of projects in that province's heavy oil areas has also been concluded. Petro-Canada, a major holder of oil sands leases, will be undertaking a leading role in encouraging heavy oil resource development.

It may be possible, with the cooperation of the Alberta and Saskatchewan governments, to obtain for Canadians a million barrels a day by 1990 of Athabasca type oil and heavy oils from Cold Lake and Lloydminster. This can come only through initiatives taken, in cooperation, by the governments of Canada and the producing provinces and industry to provide the necessary fiscal conditions. And desisions must be taken soon to meet the challenge of developing the needed technology that will assure the promise of greater energy self-reliance in the years ahead.

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# Syncrude—and Canada's oil situation

*Reviewed by Frank Spragins, chairman, Syncrude Canada Ltd.*

● *"There is a popular misconception in the public mind about energy resources. People are not concerned about them because they feel that modern technology can provide new sources of energy at the drop of a hat; but these things cannot be done overnight."*

● *"Unless major new sources of energy are brought into play immediately, Canada is certain to face an energy crisis of major proportions in the mid-1980s."*

● *"Alberta (has) long-range potential relative to the world-wide energy situation because, of our extensive reserves, both oil and coal will last longer than any other presently visible commercial supply of energy. The problem is that, despite our own secure position in long-range terms, it will be a position difficult to maintain when all the other provinces in Canada will be in dire need. That will be a small scale version of what we may have to face in the next century when the world will be short of energy and Alberta (and Canada) will still have a good supply left."*

Taken out of their context, these are some of the comments made by Frank Spragins, Chairman of Syncrude Canada, in an interview with Construction Alberta News.

"There is a popular misconception in the public mind," he said, "about energy resources. People are not concerned about them because they feel that modern technology can provide new sources of energy at the drop of a hat; but these things cannot be done overnight. I came to the Syncrude project 18 years ago, and I will have been here 20 years before the first barrel of commercial oil is produced.

"I think the shortage of energy and oil is going to be felt very soon — on a nation-wide basis certainly in the next 20 year period. Maybe it will come even earlier than that, because if you are looking at the development of major new resources you have to plan in terms of a 20 to 25 year time frame.

"Syncrude, in its relationship to the opening up of a new resource, is a step in the right direction, but Canada needs not one but many Syncrude-size projects if all of Canada is to enjoy the benefits that will accrue to Alberta. Unless new major sources of energy are brought into play immediately, Canada is certain to face an energy crisis of major proportions beginning in the mid-1980s.

"The plain fact is that Syncrude is about 15 years late. This forthcoming energy crisis is no secret. Projections by the National Energy Board, the Alberta Energy Resources Conservation Board and the economic departments of many energy-based companies clearly predict a wide gap in the supply/demand curves for the 1980s — particularly those relating to crude oil, a product upon which a major portion of our national economy is based. I feel compelled to add my voice to those who urge action in preparing now to meet Canadian energy requirements ten or more years hence which, without concerted action, appears to be unattainable.

"The education of the people to the facts of the situation is one of the primary objectives that should be in the forefront of the minds of both government and industry. It seems to be difficult for the public to accept warnings of impending danger until they are actually hit by it — as, for instance, in the United States recently when extreme weather conditions combined with energy shortages to cause severe disruptions.

"As long as the public are not suffering — as long as there is plenty of gasoline at the pumps and as long as they can turn their thermostats up as high as they like — they think everything must be all right. Unfortunately, conservation is only a passing thought to them.

"Until you can relate the facts of a situation to something they can understand, they do not believe industry's warnings. Whether they believe government or not I do not know, but they must be made to understand what is in store for them.

"I have heard it said by politicians that they have to go along with what the public thinks and what the public wants. Politicians may think they are performing a democratic service by going along with public beliefs; but, it seems to me, our leaders also have a responsibility to lead, and I do not think for one moment that the public is all that gullible if logical arguments, based on established facts, are presented to them.

"With particular reference to the Athabasca tar sands, practically every agency, political and otherwise, has expressed concern about going ahead at this time, and I have often heard it argued as to why we should develop such an expensive product at all when oil is still readily available from places like Venezuela and the Middle East. When the Syncrude plant goes on stream, world oil will cost in the neighborhood of $15 a barrel. If we pay that $15 a barrel to Venezuela or the Middle East, which is the trend we are in now, that money does not help our economy in the least — other than enabling us to get our oil — but simply goes to line the pockets of producers in foreign countries.

"If we look at Athabasca on a nation-wide economic basis, that $15 we are spending to build up that resource will provide thousands of jobs for Canadians. In addition, through the "multiplier effect", the influence of Syncrude expenditures gets spread around extensively in Alberta and in the nation, many sectors of which are not directly related to resource development.

"Quite apart from that, we can see the writing on the wall. We can see that in time, world sources of supply are going to dwindle and we must depend on developing our own new resources if we are not going to be the first to suffer.

"There has been a lot of criticism in the press and elsewhere about spending the taxpayers' money on tar sands projects; but we can take the example of Ontario, where there was a lot of criticism about the $100 million the province was investing in the Syncrude project. It was said that all this taxpayers' money was being spent and probably nobody would get anything out of it. But within a short period, we were placing orders in Ontario for over $250 million worth of equipment and construction supplies — and, in all probability, we will continue to buy operating supplies there for the life of the project.

"If we look at the effect of that business in manufacturing, income tax revenue to the government and the multiplying effect on the economy generally, we see that Ontario will have been more than paid for their entry into the Syncrude plant and will have recovered their $100 million long before the project is complete, without considering their proportionate ownership of all the oil produced. You can apply the same principle to all three governments who have invested money in the plant.

"Currently, the Syncrude project spends approximately $1.6 million a day in the city of Edmonton, which either directly or indirectly goes mostly for labour. From the tax point of view, the federal government gets the first crack at that, but this will provide services and help create other business from which, in due time, the government will derive additional tax revenues. In commerce and industry, particularly in Alberta, this $1.6 million a day is creating a lot of secondary business and is certainly playing a major part in keeping the economy of the province at a very high level.

"As for the taxpayer, he is certainly not suffering too much from what the federal and provincial governments are spending of the revenues they get.

"And it is not only in the construction stages of the project that the economy is benefitting. This will be an on-going project for 25 to 30 years, with a payroll of at least 3,000 people.

"So to say that you can buy oil more cheaply abroad just isn't a credible argument. If, even without any other considerations, you take into account income tax revenue from 3,000 people working for 25 to 30 years, it begins to make our oil look pretty cheap."

With regard to the economics of the Syncrude project, Spragins went on, "We have said that we can make this plant go if we can sell the oil at an international price." There were significant outgoing commitments for heavy, sophisticated equipment, not produced in Canada, that had to be purchased in the international market — unfortunately at a time when the demand for heavy equipment was at a maximum due to the crisis in other countries brought about by OPEC price increases. The draglines, for instance, were purchased in the United States and heavy reactors in Italy.

The problem was that there was currently not the demand for such massive, sophisticated machinery to justify anyone in Canada going into the business. "We will have the biggest dragline in use, and the probability is that no-one will be able to foresee when the next one is going to be required. You cannot set up a manufacturing plant to produce such big machines for one order and then wait for five to ten years for a chance at another order. At least for the foreseeable future, we will always face this problem of having to go out of the country to obtain certain pieces of equipment.

"The current rate of return in tar sand development is not sufficient to attract capital investment on a large scale. However, long-range potential provides the incentive to go ahead. One more tar sands plant, equivalent to Syncrude's and Syncrude's expansion potential, would probably make Alberta completely independent of outside requirements of conventional oil for all of the foreseeable future.

"Although Alberta appears secure, the rest of Canada will find itself in an extremely vulnerable position well before the turn of the century. However, the unfavorable balance of supply situation, which will begin to develop within Canada during the 1980s between east and west, will only be a hint of a more serious imbalance as world energy begins to run short. Hopefully, by that time, Alberta and Canadian frontier areas will have picked up Canadian requirements, but Canada as a whole will not likely be able to face world demand."

*Frank Spragins*


## PLAIN TALK

### About job safety on construction projects

*by Frank Fieseler*

*Security and Safety Manager, Canadian Bechtel Limited*

The most important aspect of safety is that it is much more than a planned program. Unless the concept of doing one's job in a safe manner is implanted in the minds and attitudes of all employees, a safety program is simply another manifesto from management.

Obviously, however, to achieve this goal, there must *be* a policy and there must *be* a program. At Bechtel Canada the policy is clearly laid down in our Safety Procedure Manual. This spells out management goals; lines of safety responsibility, methods for communicating the rules to all concerned; rule enforcement procedures. It covers record keeping, accident reporting and investigation, first aid policy and responsibility, safety education, specific safe practices. Our safety rules are deliberately more stringent than those laid down by the several levels of government. Our rules are uniform for every province.

So much for policy: what about that all-important attitude defined in the first paragraph. We have found that the great majority of employees understand that the rules are made for their welfare, and those they work with. Unfortunately, there are always the exceptions, and for these the penalty is severe. Any employee who wilfully breaks Bechtel Canada safety rules is dismissed.

In brief, a safety program achieves most of its success because of plain common sense—but it must be backed by decisive action.

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# Syncrude Project— Alberta's perspective

*Written for Construction Alberta News by Don R. Getty, Minister of Energy & Natural Resources, Government of Alberta*

The Alberta Government's first significant involvement with the Syncrude Project began in 1962 when the Syncrude consortium first applied to the Oil and Gas Conservation Board for permission to build an extraction plant capable of producing 100,000 barrels per day of synthetic crude oil. The application was refused because of the policy at the time of assuring conventional oil suppliers a sufficiently large market. The application was resubmitted in 1968, and in 1969 Syncrude was given permission to proceed. The present production capacity of 125,000 barrels of synthetic crude was authorized in 1972.

Negotiations between the original Syncrude Participants (Imperial Oil Limited, Canada-Cities Service, Ltd., Gulf Oil Canada Limited, and Atlantic Richfield Canada Ltd.) and the Alberta Government regarding revenue sharing arrangements continued until agreement was reached on September 14, 1973 when a Letter Agreement was signed outlining the terms of the revenue sharing, public participation in the project, and Canadian content.

The basic royalty terms agreed to on September 14, 1973 provided the Alberta Government with a 50 per cent share of the net profits of the project. The government also retained the right to convert the net profit royalty to a 7½ per cent gross production royalty, should that prove to be more advantageous to the citizens of Alberta.

The other major item in the September Letter Agreement was the provision for public participation in the project. The agreement provided that Albertans, through their government and the Alberta Energy Company, would own 80 per cent of the pipeline and 50 per cent of the utilities plant and that the Alberta Energy Company would have an option to acquire a five to 20 per cent share of the project at a time when the actual costs of construction were known.

The deal struck with the Syncrude consortium was, at that time and still remains, an extremely important and beneficial arrangement for the people of Alberta. It provided for two firsts in terms of government-industry relationships.

1. The royalty was established on a partnership basis which will allow the people of Alberta a 50/50 participation in the profits.
2. Albertans were given the opportunity to invest in a major resource development in their province.

After the terms of the profit sharing were agreed upon, the Syncrude Participants turned their attention to the actual construction of the project. Site clearing commenced in December of 1973 and the construction of the plant commenced in 1974.

On December 4, 1974, Syncrude was faced with the possibility that the project would be stopped when one of the four original participants — Atlantic Richfield Canada Ltd. — withdrew from the project because of a doubling in the cost estimates from 960 million to two billion dollars. As a result, the three remaining Participants took two actions.

1. The construction of the project was put on hold and underwent a dramatic slowdown.
2. The three remaining companies issued a general invitation to other investors.

The Alberta Government also issued a telex to the federal government and other provincial governments asking them to consider investing in the project. On December 20, 1974, the Alberta Government commissioned four studies to review and comment on the doubling of the cost estimates, the economic impact of the project and the legal implications of the situation at that time. The consultants indicated that there was no evidence to show that the original estimate was understated nor was the December, 1974 estimate unduly inflated. The economic impact report stated that the Syncrude Project would have a major impact on the Alberta economy both during the construction stage and during its 25-year operating life.

During the period that the studies were being carried out, the three remaining Participants were unable, despite intensive efforts, to obtain other private sector participation and on February 3, 1975 negotiations were held in Winnipeg which resulted in three governments, Alberta, Canada, and Ontario, taking an equity position in the project. The participating interests agreed on were:

| | |
|---|---|
| Imperial Oil Limited | 31.25 per cent |
| Canada-Cities Service, Ltd. | 22.00 per cent |
| Gulf Oil Canada Ltd. | 16.75 per cent |
| Canada | 15.00 per cent |
| Alberta | 10.00 per cent |
| Ontario | 5.00 per cent |

The other items agreed upon were:

1. No change in the original revenue sharing agreement.
2. Alberta would assume 100 per cent ownership of the non-risk utilities plant and the non-risk pipeline.
3. Gulf and Cities both sought debt financing in the amount of $100 million each from the Alberta Government to enable them to increase their risk equity investment. Alberta agreed to provide this financing on the following basis:
   (a) the debt would be adequately secured,
   (b) the debentures provide the citizens of Alberta with a reasonably assured interest income,
   (c) the debentures contain a provision whereby they could be converted into an equity share if the project showed a good profit potential.

These arrangements brought an end to the uncertainty of the future of the project. They illustrated the co-operation between the private sector and three governments representing the consumer, producer and the national interest.

With the signing of the Winnipeg Agreement, the construction of the project resumed and has continued steadily. At the end of March, 1977 construction was 68 per cent complete with the project essentially on budget.

Subsequent to the signing of the Winnipeg Agreement the six Participants met to work out definitive agreements based on the September, 1973 Letter Agreement and the Winnipeg Agreement. Because of the size, complexity and the 25-year operating life of the Syncrude Project the negotiations were extremely complex and were not completed until April 30, 1976 when the definitive agreements were signed by all parties.

Because of the involvement of the Alberta Government as both resource owner and participant, a separate organization — Alberta Syncrude Equity — was created within the Department of Energy and Natural Resources. Alberta Syncrude Equity is headed by T.R. Vant, Chairman, with the responsibility of managing Alberta's 10 per cent equity participation and monitoring the convertible debentures of Canada-Cities Service, Ltd. and Gulf Oil Canada Limited.

The Alberta Government considers the Syncrude Project to be of great importance in the following areas:

1. Impact of the Alberta Economy
   - Since approximately 70 per cent of the capital costs of the project will be spent in Alberta it has helped the Alberta economy avoid the economic problems faced by other areas in Canada.
   - The majority of the people employed in both the construction and operation of the project will be Albertans.
   - The Syncrude Project has helped expand certain segments of Alberta industry such as the manufacturing sector and consulting engineering firms.
2. Government and Industry Co-operation
   - This project is successfully demonstrating that both government and industry can participate in the management of a large project as partners.
3. Canada's Oil Supply
   - The Syncrude Project, when fully operational, will produce 125,000 barrels per day of synthetic crude oil which will help to reduce Canada's dependency on imported oil.

The other commercial oil sands operation, that of Great Canadian Oil Sands Ltd., has recently begun to return an annual profit after many years of losses. This reflects the success of intensive efforts to achieve a sustained production level, while reducing costs. I hope that the company will continue to show a profit and demonstrate the economic benefits of oil sands extraction plants.

Further development of the oil sands has become increasingly important to Canada since there have been limited discoveries in the frontier areas such as the Arctic and the East coast in spite of the substantial and expensive exploration carried out in these areas. The oil sands, by comparison, do contain large reserves of bitumen and technology has been proven to extract the bitumen and produce a synthetic crude from those sands which are accessible by surface mining. These surface mineable oil sands are estimated to contain 26.5 billion barrels of synthetic crude. The only barrier to recovery of this resource is the high cost involved, and Alberta is confident that this barrier can be overcome.

The majority of the reserves in the oil sands are not accessible by surface mining methods and the bitumen must be recovered by in situ methods for which commercial recovery has not yet been demonstrated. To spur research and development and to enhance the dissemination of results the Alberta Government has created the Alberta Oil Sands Technology and Research Authority with a mandate to support both laboratory and field research in the area of in situ recovery processes. The authority and industry have underway a $130 million research program of five field experiments to test advanced, in situ oil recovery concepts. In addition, AOSTRA recently finalized research agreements worth $1 million for nine projects on in situ recovery which will be carried out at the University of Calgary. The initial funding for AOSTRA of $100 million has been increased to $144 million.

When considering future development of the oil sands, all Canadians must realize two things:

1. The time of inexpensive energy supplies is past and new energy supplies such as the oil sands and the frontier areas will be expensive to produce, and
2. Alberta has sufficient supplies of oil for its internal use for the foreseeable future and hence cannot be expected to bear the total cost of developing additional energy supplies which will be used by other Canadians.

The Alberta Government is hopeful that through discussions with the federal government and industry suitable terms can be agreed on to allow development to proceed.

Alberta is currently holding discussions with Imperial Oil Limited regarding the development of a commercial-sized in situ plant in the Cold Lake area. Discussions are also being held with the federal government to attempt to develop alternative fiscal and revenue sharing policies which would encourage further development of the oil sands.

In summary, I feel certain that the oil sands, with their immense oil reserves, will see further development thereby providing employment for Albertans and other Canadians, spurring development of support industries, providing a much needed resource and reducing Canada's dependency on imported oil.


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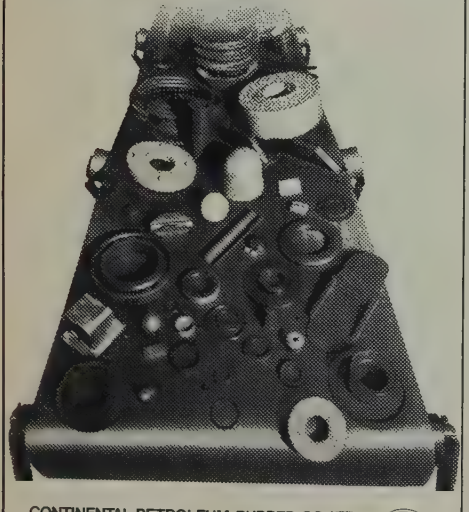

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# "Our first truly national energy project"

*But more Syncrude-type plants are needed says Brent Scott, president, Syncrude Canada Ltd.*

In the Athabasca Tar Sands Canadians are working together to build our first truly national energy project. Syncrude is on schedule, and it is close to budget. And it is demonstrating that when the chips are down Canadians can co-operate to start solving their energy problems. Generally we are very pleased with the success of the job to date. We have the engineering work 100 per cent complete, and our recruitment of engineers and the necessary number of qualified people, is going forward vigorously.

All the major equipment has been ordered and all the necessary equipment so far required is in place. This is a very significant step that might well have involved work hold-ups and transport problems. All this is also behind us.

The balance of work left to be done involves a high input of skilled workers, but we are blessed with a good availability of suitable labour. Our permanent staff is now at a strength of 1400, which means that we have achieved the half-way mark in recruitment. We have most of the administrative, professional and technical people we need so far. We are currently recruiting occupational people in all skilled trades classes.

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The toughest part of any job comes at the time when you put the equipment into operation, and invariably there are problems that must be overcome in order to make the plant efficient. This applies particularly to the Syncrude project where the equipment is so sophisticated and so very big, and I am sure we are not going to escape that stage of the job.

It must be remembered that, when you are comparing world-scale industrial projects — and there are several bigger than we are, including the James Bay hydro-electric scheme here in Canada — Syncrude is probably the largest in terms of complexity. Other projects involve a single technology and it is only in their proportions that they are different from what has gone before, but in Syncrude we have been involved not only with bigger equipment than has been used previously but also with the bringing together of many technologies — mining, refining, utilities and housing — and it is these that have given the project its complexity.

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One of our major concerns that will remain with us right to the end of the project will be to keep the costs as near the projected figures as possible, and cost control will continue to be a most important factor. Throughout the course of the job the estimating of costs and the monitoring of actual costs, together with the detailed study of cost-producing items, have occupied a very high proportion of our time and attention.

When the plant is eventually in full operation we will be producing 125,000 barrels of oil a day, but obviously the output of our plant alone won't meet Canada's demand, and it will take a good many plants of this type to meet the country's requirements, for Syncrude will not in itself offset Canada's declining oil production.

Every day the significance of the tar sands looms larger, and more and more people are realizing that the Athabasca Tar Sands are now our largest proven oil reserve and that it is time to cash in on their potential.

We know the oil is in the sands, and in the shallow tar sands we have the technology to get it out. There is enough oil in the shallow tar sands to supply ten more plants the size of Syncrude. The shallow tar sands contain more oil than all the rest of North America's proven reserves, including Alaska. And there is still more oil in the deep sands although the technology for producing it in large quantities is not yet proven.

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It is not only in production, however, that tar sand development is important. It is of great significance to the country's manufacturing industries, know-how and manpower skills that there should be a continuance of tar sand plant construction. It would provide a continuous steady demand in engineering, materials supply and labour, and if there were to be a new plant, say, every four years then the people and materials would flow from one to the other without dislocation.

Another positive feature of tar sands development is the fact that we are now gaining a much better understanding of how to develop the tar sands without major damage to the environment.

There are two aspects to solving the energy gap ahead: supply and demand. The Athabasca Tar Sands can make a major contribution to increasing our supply and reducing our dependence on imported oil. As to demand, I think we all realize that, until now, because energy has been relatively cheap, all of us in North America have been using it wastefully. There are many ways in which we can reduce our unnecessary use of energy by adaptations in our life-styles and by the application of better technology to such areas as home and office insulation, mass transportation and so forth, for energy conservation is essential.

We want Canadians to learn as much as possible about our company and about the tar sands themselves. The full potential of the tar sands is not well enough understood by all Canadians, and as developers of the tar sands we have a major stake in public education to improve this understanding.

We are encouraging this awareness by assisting classroom teachers who want to develop learning materials about the tar sands for use in schools, and with the help of Syncrude's Educational Services groups of teachers are now developing these classroom materials for use in science courses, social study courses, biology courses and the like across Canada. The first such unit for use in general science courses in high school, is now in distribution, and teachers in several provinces have already placed orders for it.

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To sum up, Canada's need for new energy supplies is very critical. A failure to develop such supplies will inevitably lead in only a few years to gasoline rationing and major shortages with calamitous results. The tar sands cannot by themselves solve this crisis because they cannot be developed overnight. But if we accelerate tar sands development using plants like Syncrude we can reduce our dependence on imported oil in the late 1970s and the 1980s. And we could eventually return Canada to self-sufficiency in oil.

The Syncrude project is showing that major plants can be built to extract the oil from the tar sands.

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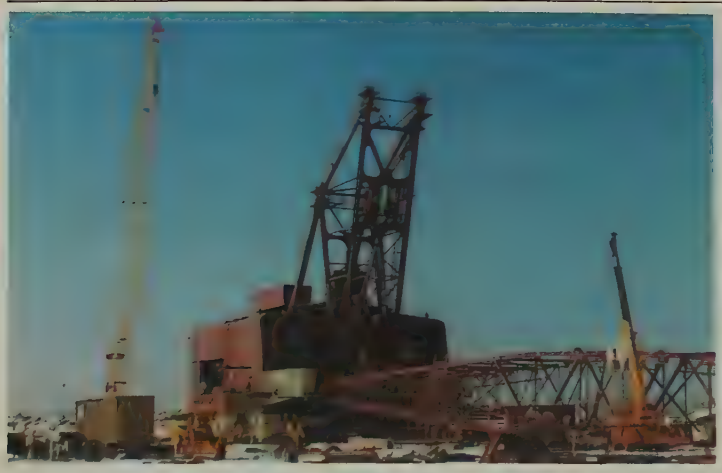


*One of the massive draglines under construction*

*One of the two dragline shoes on which it can move, taking one step at a time*

# Mining operation challenges superlatives

## Biggest of its kind in the world

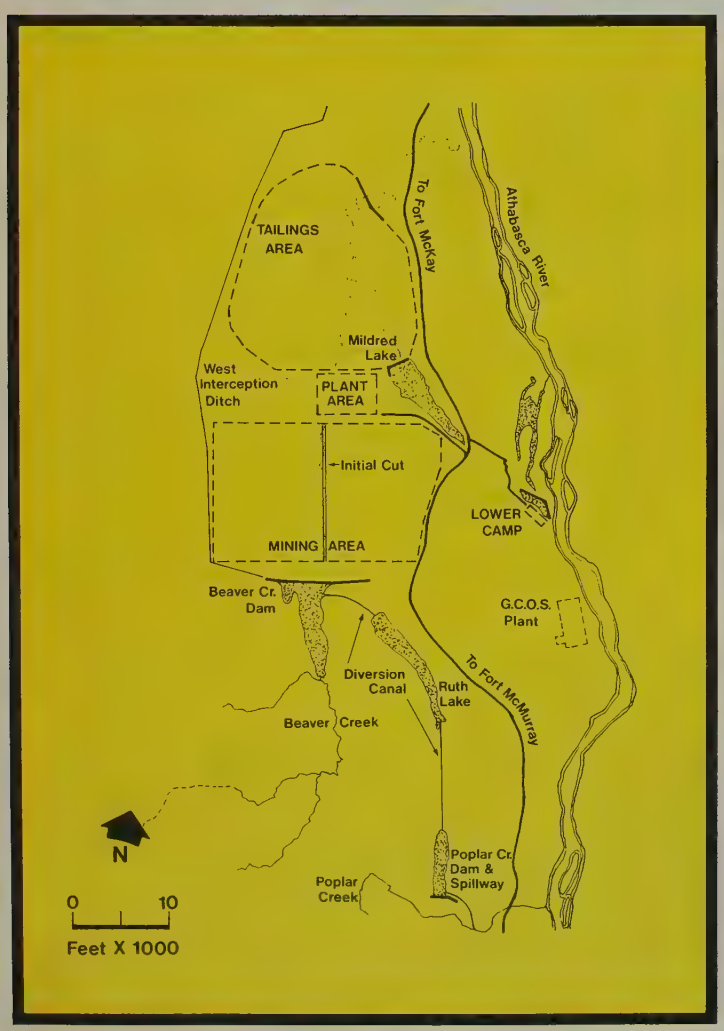
In its mammoth proportions and imaginative conception the Syncrude mining operation challenges superlatives.

The situation is that, in depths varying in thickness from zero to 50 feet, a cover, or overburden, of sand, gravel, clay and shale overlies the bitumen-charged tar sand.

The object is to strip off this overburden and to dig out the tar sand to a depth of 200 feet.

This operation — in terms of material moved the biggest mining operation in the world when in full production — is planned to continue without pause, 24 hours a day, seven days a week, year-round, for the next 25 years and it will, in time, exploit the tar sand potential over an area of 11 square miles.

To achieve this object four massive, $30 million draglines are currently being assembled on site, and two of them will begin digging this summer — initially to strip off the overlying gravels and to stockpile tar sand in preparation for the plant's mid-1978 start-up.




The towering draglines have booms longer than a football field and buckets capable of scooping up enough material to fill a large living room.

In operation, the bucket, which is suspended by hoist steel cables from the boom, is dropped to the mine surface and pulled towards the machine by drag ropes winched in from the huge machine house. By rotating the machine and skillfully manipulating the cables and ropes the operator can position the bucket to dig and dump in any location. The bucket peels off two or three feet at a time and is hoisted while the dragline swings round to dump its load on to a pile known as a "windrow".

As the work progresses the enormous machine is able to "walk" backwards on its own shoes which will work in unison to take one step at a time.

The draglines are, however, only the beginning of the long transport "train" required to get the tar sand from the mine to the extraction plant where the heavy oil, bitumen, is separated from the sand.

Paired with each dragline is a 428-foot-long bucketwheel reclaimer which links it with the conveyor transport system. The 14-bucket wheel is 41 feet in diameter and its function is to scoop up the tar sand from the windrow created by the dragline and transport it down its 328-foot-long bridge to a conveyor.

Most of the steel construction for the reclaimers is being manufactured by GWS Krupp of Edmonton; some parts are being made in Calgary and in Dundas, Ontario; the bucketwheels themselves, together with the crawlers that enable the big machines to move about the site, are being constructed in Germany.

As a sidelight on this particular part of the operation, Albertan engineering history has been made with the construction in Edmonton of the massive bucketwheel booms for, in the words of a GWS Krupp executive, "with them we get a totally different kind of construction — a more difficult, highly sophisticated custom-built type of manufacture."

The scalping of oversized lumps that would cause damage to the conveying system is done by lump separators located at the point where the reclaimers discharge their material on to the conveyors. The separator is a 16-inch vibrating screen mounted on a frame which straddles the conveyor, and it can be removed from the system if not temporarily needed.

From the separator the tar sand drops through travelling hoppers before being carried away on the conveyor belting. The steel cord belting for the conveyors is six feet wide and one-and-a-half inches thick, and some 17 miles of conveyors will ultimately be in operation around the mining area.

Tar sand deposited on the belt will move 860 feet in one minute — equivalent to the distance of two-and-a-half footballs fields.

The massive conveyor head stations at the face of the mine can be moved with the help of hydraulic walking "legs", and the long lengths of conveyors are shifted laterally with the help of dozers. This allows the mine pit to be expanded as time passes.

The conveyors transport the tar sand from the reclaimers to radial stackers which direct it on to what are known as surge piles located near the extraction plant, the object being to stockpile the tar sand to permit continuous operation by the mining equipment. The 238-foot-long stackers, which are an elevated extension of the conveyor system, are able to swing back and forth to feed various bins which take the tar sand underground into the extraction feed system.

### Challenge of imponderables

Thus briefly described at the risk of over-simplification the mining operation appears straightforward and entirely logical, albeit highly sophisticated.

But in preparation and practice it has been far from clear-cut — and, with the application of such massive machines, which in theory are no more than an elaboration of what have gone before, the future could hold even more imponderables than those already encountered.

Because of this, the performance of the draglines and the other mining machines — the bucketwheel reclaimers, lump separators, conveyors and stackers — will have to be closely observed and monitored.

To quote Dave Adam, director of Mining Engineering, "We are dealing with a material unique in mining operations. In fact, the whole operation is unique, and one of the difficulties at the very outset was that the number of people available with experience in the methods and the mining equipment to be used in such an environment was naturally very limited."

Bringing this mine into production will, as Adam points out, "represent the culmination of mine design and planning activities over many years."

Intensive studies began in 1970 to evaluate the composition and stability of the geological formations under the mine surface — information vital to the operations side of the Mining department if the miners are to know how and where to dig with their great machines.

Mine site preparation started in 1973 with the ensuring of access to the mining area and the stablization of mine surfaces, and this was followed by road building, surface draining, muskeg removal, overburden dewatering, aquifier depressurizing and surface grading — not to mention the diverting of Beaver Creek which was straddling the mining area and which, as a separate operation, is described elsewhere in this issue.

There were fundamental decisions to be made, too, on the best methods of procedure — not the least of which related to the use of draglines as opposed to bucketwheel excavators such as are used by Great Canadian Oil Sands — on the application of back-up procedure, the duplication of equipment, to ensure continuity of operation in the event of breakdown, and on the provision of adequate equipment, such as the unique power plant to drive the enormous machines, to service the gigantic plant that would be necessary.

To describe the Syncrude mining operation simply as unique is still, probably, an understatement.

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*The extraction building showing (right) the conveyor from the feed system*

*The electrostatic precipitators with the two fluid coker units and the C.O. boilers rising behind*

# What the Syncrude plant is all about

## The production of synthetic crude oil

**Broadly speaking, the Syncrude production complex, occupying a square mile of the Athabasca Tar Sands — with ancillary features up to 12 miles away — comprises an open-pit mine, which is described elsewhere in this Supplement, a hot water oil extraction plant, and hydration-demineralization and bitumen upgrading facilities.**
**And, equally broadly speaking, the object of the processing operation is to separate out the bitumen and then upgrade it to a lighter, mineral-free synthetic crude oil, with reduced sulphur and nitrogen content, that is transportable by pipeline and, most importantly, marketable.**

Tar sand is not a uniform material; it varies widely in quality and it is intermixed with a variety of other materials, foremost of which are barren sands and clay seams. Because of the variable nature of the deposit, it is inevitable that much of this lower grade material will be mined along with the oil-containing tar sand.

The tar, or bitumen as is generally referred to, will average about 11.5 per cent by weight of the material fed to the plant.

The tar sand consists primarily of a water wetted, semi-consolidated sandstone, the interstices of which are filled with bitumen.

As a consequence of the properties of the material, the extraction process utilizes hot water to effect disintegration of the tar sand and liberation of the oil flecks from the sand grains.

Aeration of the bitumen, which is heavier than water, is a necessary function of a slurrying step which enables the bitumen to float as a froth and be separated from the bulk of the mineral matter.

The bituminous froth as produced is an impure substance consisting of about 65 per cent by weight bitumen, 25 per cent water and 10 per cent mineral matter. It is necessary to remove most of the physical contaminants before the bitumen can be upgraded to synthetic crude oil, and a dilution centrifuging operation is employed for this operation.

Syncrude will upgrade the bitumen by converting it to lighter products in two parallel fluid coking units. The total capacity of these two units is greater than the combined capacity of the other ten fluid coking units currently in existence in the world. These units are typical of a number of processes and equipment items employed in this project in that they rank among the largest of their kind that have been built and as such represent an extrapolation of existing technology.

Because of the high cost of the mining and materials handling operations, it is desirable to minimize these steps to the extent possible; one way of accomplishing this is by achieving high extraction and upgrading recoveries.

Fluid coking was selected in preference to delayed coking which is the method employed elsewhere, notably by GCOS, primarily because a lower percentage of the bitumen in converted to coke.

A yield advantage of about 7 per cent by weight was shown based on pilot plant tests carried out on behalf of Syncrude.

This extra recovery splits up between light gases and distillate fractions, which are subsequently hydro-treated to synthetic crude components.

*The hydrogenation unit under construction*

The fluid coking process employs more severe operating conditions than does the delayed coking process, which leads to greater degradation of the distillate products. For this reason, the hydro-treating units required are more sophisticated than conventional hydro-treaters. To ensure that adequate process designs were developed, extensive coking and hydro-treating pilot plant operations were conducted.

Bitumen contains approximately 5 per cent sulphur by weight. Some of this ultimately resides in the fluid coke, but much of it is converted to hydrogen sulphide in the various upgrading steps. As a consequence, approximately 1,000 long tons per day of sulphur will be produced as a by-product from the operation.

Two hydrogen production units, each with a capacity of 90 million cubic feet per day will supplement the processing facilities.

To effectively utilize the large amount of process gas produced by the fluid cokers, a highly efficient power plant consisting of gas turbine generators followed by high pressure boilers, followed in turn by a combination of back pressure and condensing turbine generators, is now nearing completion and will provide up to 260 megawats of power for the project. A high voltage transmission line, which will connect the provincial grid to the power plant, will assist in absorbing the power swings created by the draglines.

The processing units and accompanying tank farm and other offsite facilities will cover an area of about 500 acres. Process control of the complex will be from a main control centre.

Meanwhile, there is the problem of the fine mineral matter which has accompanied the bitumen up to and through extraction.

Following hot water extraction of the bitumen and subsequent hydraulic transport of the sand tailings, the fines must be settled from the water stream. They settle and consolidate very slowly and to an ultimate volume considerably in excess of that which they occupied in their native state.

For this reason, it is necessary to create a storage basin in which the separation can be effected. Decanted water is recycled to the plant for reuse in the process. A large area is required to achieve clarification of the recycle water but even more important is the volume required to accommodate the settled fines.

The settling area, which is located on the northern part of the lease, will hold the settled fines for the 25-year operation. The distance from the Poplar Creek control structure on the south to the 200-foot high tailings dam on the north is about 12 miles.

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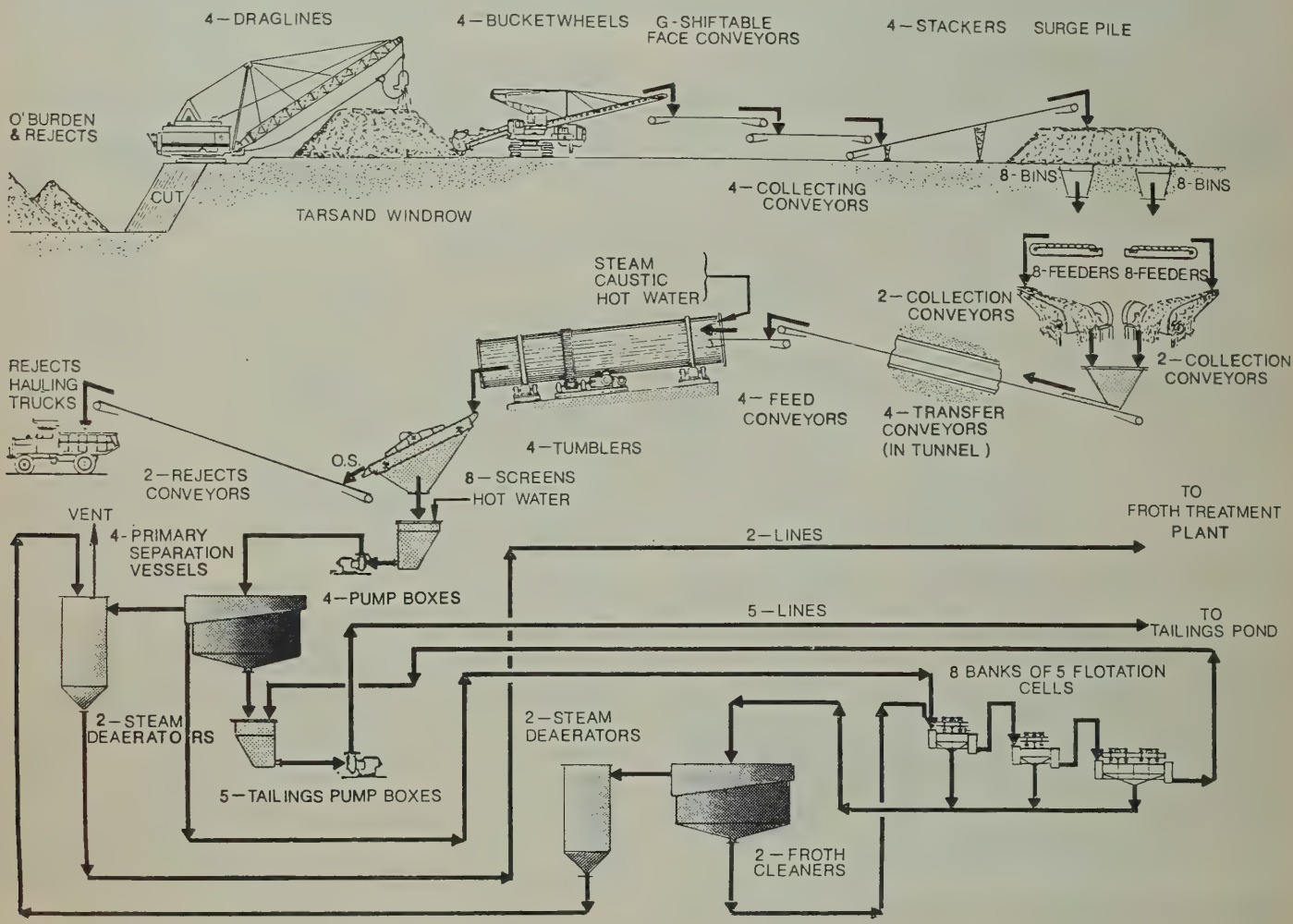

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# The history of tar sand exploration

When, around the middle of next year, the first synthetic crude oil is produced by the Syncrude plant 25 miles north of Fort McMurray, coincidentally but significantly it will mark the 200th anniversary of the first sighting of the Tar Sands of Alberta by a white man.

He was Peter Pond, a now legendary figure, who worked for the North West Company and was lured to the Athabasca by rumours of the rich harvest of furs to be taken in the area. The fur trading post he established at the junction of the Clearwater and Athabasca Rivers was known as the "Fort of the Forks". It was one of many to be built over the next hundred years in this strategic spot at the foot of a vast waterway leading to the Arctic. The last fort to be established on the site in 1870 was called Fort McMurray, a name that stuck to the settlement which later grew up there.

Eleven years after Pond reported seeing the sands, Alexander Mackenzie, a Scottish-born explorer and partner in the North West Company, visited the area. His first sight of the tar sands prompted the following description: "At about 24 miles from the fork are some bituminous fountains, into which a pole of twenty feet long may be inserted without the least resistance. The bitumen is in a fluid state, and when mixed with gum, or the resinous substance collected from the spruce fir, serves to gum the canoes. In its heated state it emits a smell like that of sea-coal".

Other famous explorers were to view the tar sands over the next several decades. David Thompson, the noted mapmaker, surveyed the Athabasca River between the Clearwater River and Lake Athabasca in 1803. Later visitors to the bituminous sand country included Arctic explorers, Franklin, Richardson and Simpson.

These men were to be followed by others, less famous but no less hardy — fur traders, trappers, prospectors and adventurers. They did little to change the face of the land, however, and it was still a vast and virtually empty wilderness that greeted Prof. John Macoun of the Geological Survey of Canada when he arrived in the area in 1875. Macoun reported on the tar conglomerates, and tar springs which he saw on a trip up the Athabasca River.

*One of the first uses of tar sands bitumen was the experimental paving of an Edmonton street in 1915.*

Almost a century after Pond's introduction to the tar sands, the area was beginning to attract a new breed of explorer — geographers, geologists and engineers with the knowledge and technical skills to assess the potential of the sands and suggest ways of unlocking their riches.

Later in the last century R.G. McConnell and F.H. McLearn visited the tar sands. McConnell studied the geology along several rivers of the Athabasca region and concluded that the bitumen must be coming from pools of oil, which could be reached by drilling.

It was decided that a well should be dug at Athabasca landing, about 100 miles north of Edmonton. The year was 1894 and machinery for the venture was shipped from Toronto to Edmonton by rail on the newly-completed C.P.R. then laboriously confirmed that the tar sands, which are visible for 118 miles along the Athabasca River bank, had sufficient commercial potential to warrant further exploration and research.

Initially, the Athabasca Tar Sands were owned by the federal government, as were all of Alberta's natural resources. A memorandum of agreement was signed in December of 1929 between the federal and provincial governments to facilitate transfer of ownership. These rights of ownership were obtained by Alberta effective August 1, 1930.

As early as 1919, when the Alberta Research Council was formed, the province had already taken steps toward finding a practical method of separating the sand and clay from the bitumen, as the oil is called. Of the businessmen and drillers active in the area, one, R.C. Fitzsimmons, built a small commercial plant to actually extract the bitumen from the tar sand.

In 1929, oil separated from the Athabasca Tar Sands by the mine branch of the federal government was used for road paving experiments in the City of Edmonton.

Early research established hot water extraction hauled by teams of horses to the drill site.

The effort was doomed to failure. Although drilling continued off and on for four years, the hoped-for oil pool was never found. Drilling crews had to contend with problems that ranged from sudden heavy gas flows that sent particles of rock shooting out of the bore hole like rifle bullets, to machinery that constantly clogged under the onslaught of the heavy oil and sand. Eventually, it was decided to abandon the project.

During the next two decades, entrepeneur Count Adolph Von Hammerstein and others took up the same challenge and a number of holes were drilled in the bituminous sands and limestone of the Athabasca region, but nothing of economic importance in the way of oil or gas was found.

Meanwhile, the government had also been taking an interest. The Geological Survey of Canada realized that the tar sands justified a detailed geological study and in 1882 Robert Bell was sent to "examine more carefully than hitherto had been done the relations of the rocks of the river, especially with reference to the modes of occurrences of petroleum and asphalt." These studies and others as the most promising method of commercial separation of the oil from the tar sands. In 1936, a developer named Max Ball experimented with a version of this process and started a company called Abasand Limited to explore the possibility of producing oil from the tar sand. The location of this plant was south of Fort McMurray where high grade tar sand exists. A diesel oil product resulted. It was pumped through a small pipeline to Waterways where it was loaded on barges and shipped north for use in mining camps on Lake Athabasca.

In 1941, when fuel oil supplies were threatened by the war in the Pacific, the federal government decided to investigate the feasibility

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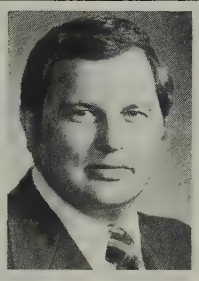

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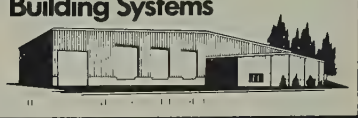

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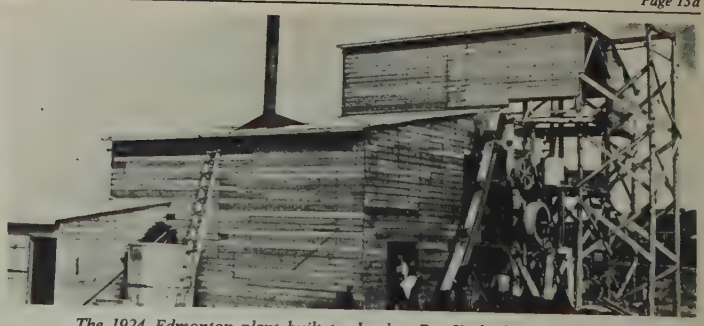
*Fort McMurray's main street in the middle 1920s*

*(Photographs: Provincial Archives of Alberta)*



*The 1924 Edmonton plant built to develop Dr. Karl Clark's "hot-water flotation process" of separating bitumen from tar sands.*

of producing oil from the tar sands as a World War II emergency project. A committee was appointed to study the Abasand facilities. About this time Ball decided to rebuild the whole plant and it was dismantled for this purpose. Meanwhile, the threat to the west coast ceased to exist, but the government decided to go ahead with the investigation which included purchasing the Abasand facilities. The plant was reassembled but never really worked as well as it had before dismantling. A short time later the plant burned to the ground and was never rebuilt.

One of the original assignments of the Research Council of Alberta was to undertake a study of the Athabasca Tar Sands. Many studies and experiments followed through the years which, for the most park, were carried out under the direction of Dr. Karl Clark.

As a climax to these many years of effort, the Alberta government built a 500-ton-per-day extraction plant at Bitumount. During 1948 to 1949, this plant successfully demonstrated the technical feasibility of the hot water process; however, large scale commercial design and economic feasibility had yet to be demonstrated.

Although not commercially successful, these early efforts on the part of individuals, companies and governments added significantly to the store of technical knowledge which was relevant to subsequent attempts at commercial production of oil from the tar sands. Between 1950 and 1955, interested oil companies began to appreciate that early tar sands planning had been too limited in scope but when based on a sufficient scale of production and when conventional petroleum became in short supply, tar sands plants would likely become economically viable. This realization ushered in a new era of activity.

In the period following 1955, private industry once again assumed the preponderant role in tar sands development research.

Cities Service Athabasca Inc. (forerunner of Syncrude Canada Ltd.) built and operated at Mildred Lake north of Fort McMurray, a 1000 barrel-per-day pilot plant which, at its peak, employed some 150 persons in experimental work on mining, materials handling and extraction. Following 1964, this work was moved to the company's research centre in southeast Edmonton. Other private companies built and operated both mining and in situ facilities to develop or test tar sand technology.

Leading all the ventures and by far the biggest tar sands pioneer of all, was Great Canadian Oil Sands Limited.

GCOS began its plant construction in 1965 and first started to produce oil in September, 1967. The start up was understandably slow. The procedures and equipment were new and complicated. For the most part, the staff had to learn a completely new technology.

During the months of 1967 following September, synthetic crude production averaged approximately 1200 barrels per day. From then until 1970, production improved and upswings began to take place. In recent years, production has hit high levels. On certain occasions, extraction of bitumen has been in excess of 100,000 barrels per day and production of specification synthetic crude has been over 70,000 barrels per day; however, sustained production appears to be in the range of 55,000 to 60,000 barrels per day.

The Oil and Gas Conservation Board, now known as the Energy Resources Conservation Board, estimated in 1964 that the GCOS lease contained 1,031 million barrels of bitumen in good grade oil sand beds and that 630 million barrels of this reserve could be recovered.

GCOS, like Syncrude, is a mining operation. Mining in the extremely cold temperatures plus the abrasive conditions of the tar sands make it expensive, risky and highly complicated.

Although much has been learned from GCOS since they first began producing synthetic crude, tar sand oil production is still not a simple problem and, even today, new and challenging difficulties are still arising.

The Syncrude Athabasca project began in the late 1950s.

Syncrude first applied to the Alberta Oil and Gas Conservation Board in 1962 for permission to build a plant capable of producing 100,000 barrels per day of synthetic crude oil — "synthetic" because the raw oil found in tar sand bitumen requires physical and chemical alterations before it resembles most oil produced in conventional oil wells. This was refused because of the Alberta Government's policy of assuring conventional oil supplies of a sufficiently large market.

Syncrude s second application in 1968 was again delayed due to uncertainties related to the Prudhoe Bay, Alaska discoveries.

In 1968 Syncrude received permission to proceed with plans for a plant and in 1971 the Alberta Government authorized this plant to produce 125,000 barrels of synthetic crude oil per day.

As shown elsewhere in this Supplement, today Syncrude Canada Ltd. is owned by three oil companies and three governments. Each of the six participants has equity investment in the project and will receive a share of the final product according to its share of equity, ownership being divided between Imperial Oil Limited, Canada-Cities Service Limited, Gulf Oil Canada Ltd., Government of Canada, Government of Alberta and the Government of Ontario.

The responsibility of Syncrude is to construct and operate, on behalf of these participants, a facility to produce synthetic crude oil from the Athabasca Tar Sands.

Briefly described, the mining operation has two phases. The first is the removal of the overburden, the surface layer of muskeg and lean or oil-poor sand which lies on top of the tar sands. This will be done with large draglines equiped with buckets capable of holding 80 to 90 cubic yards of material. The same draglines are used to mine the tar sand once it is exposed. Following the initial opening of the mine and after sufficient tar sand has been evacuated to expose the underlying shale, the overburden will be cast directly into the mined-out area. This is the first step in land reclamation.

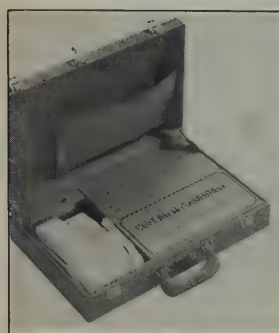
Following mining of the tar sand, it will be loaded on to a conveyor belt system which will deliver it to the extraction plant. Here it will be mixed with hot water and steam to form an air-saturated slurry. This slurry is pumped into extraction cells where aerated bitumen (as raw tar sands oil is called), which rises to the top in the form of a water-and solids-laden froth, will be skimmed off. The bitumen froth is then treated to remove remaining water and solids and fed to the primary conversion units in the initial upgrading step.

During upgrading, the bitumen is "cracked" and separated into two streams — naphtha and gas oil. Each stream will be individually scrubbed to remove sulphur and treated with hydrogen. When blended together, these two streams will result in low-sulphur specification synthetic crude oil which will be piped to Edmonton for refining and subsequent transportation to markets.

The Syncrude Project is located on Lease 17 in the Athabasca Tar Sands, 25 miles north of Fort McMurray. Preparation of the project site commenced in the spring of 1974. The target for production of the first synthetic crude oil is mid-1978. Commercial production is planned to begin at a rate of 52,000 barrels per day in 1978, doubling during 1979. Thereafter, process debottlenecking is planned to reach the government approved 125,000 barrels of synthetic crude oil production daily.

Over the 25-year life of the project, Syncrude expects to produce more than one billion barrels of synthetic crude oil from its lease.

Production will be from a mine site totalling about 28.5 square kilometres (7000 acres) in size. This mining site represents about one per cent of the area underlain by mineable tar sands in northeastern Alberta.

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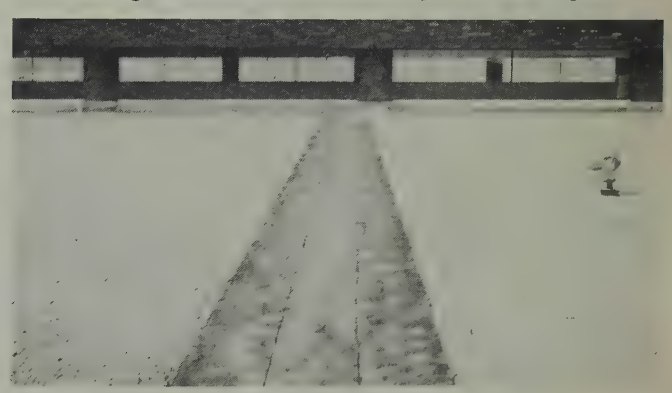

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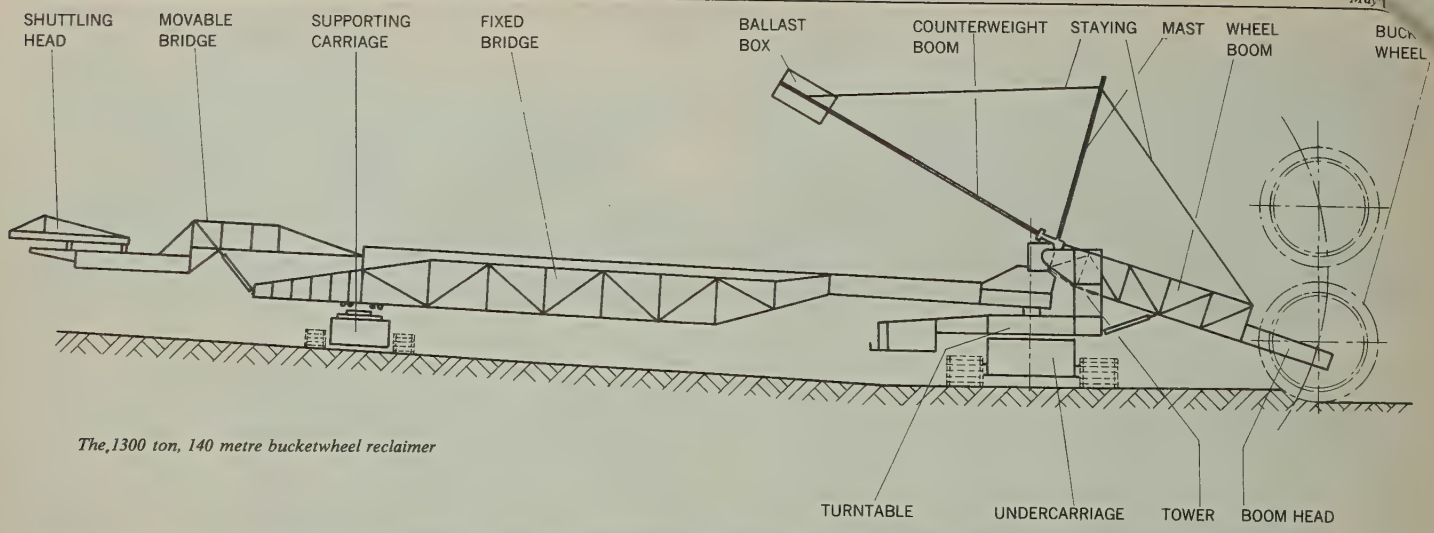


*The,1300 ton, 140 metre bucketwheel reclaimer*

# Alberta makes manufacturing history

## Advanced techniques in steel fabrications

In the rarified atmosphere of complex and sophisticated engineering, Alberta has made history with the construction in Edmonton of massive steel components for the massive reclaimers and stackers at the Syncrude mine site. This is the first time that such advanced steel construction work has been carried out in the province.

At the site, once the huge draglines have excavated and stockpiled the tar sand, the reclaimers, with a capacity of 7000 tons an hour, remove the material from the stockpile and feed it to a conveyor

The conveyors transport the material out of the excavating area to a point where it will be stacked again above the feed system which controls the supply of tar sand to the extraction plant.

The fabrication of a variety of steel structures and the manufacture of structural components for the four reclaimers and four stackers have been carried out by GWS Krupp of Edmonton.

These reclaimers are technically much like a bucket wheel excavator. With 1000 kw installed at the wheel, the reclaimer has enough cutting force to enable it to take up the material even in conditions of extreme freezing.

The over-all length of the machine is about 140 meters and the weight of the structural components alone is about 1300 metric tons. The machine is crawler-mounted on four crawler systems.

The bucket wheel, with a diameter of about 13 meters and with 14 buckets, each of which is equipped with 13 teeth, digs the material from the stockpile and feeds it over the bucket wheel chute on to a conveyor which runs within the bucket wheel boom.

Via a transfer point in the centre of the reclaimer, the material is then conveyed inside the fixed bridge on to a conveyor system which transports the material to a movable bridge at the end of the machine. The object being, with a shuttling head which runs on the movable bridge, to give the machine enough flexibility to reclaim from different positions in relation to the main conveyor system.

From behind the reclaimers, the material is conveyed to the stackers immediately adjacent to the process area.

Although the stackers are basically more simple machines than the extremely sophisticated reclaimers, they nevertheless represent a speciality unit manufactured for the first time in Alberta.

They weigh about 300 tons and are rail-mounted.The first two stackers are currently near completion. The third and fourth machines will be erected during 1977.

Both types of equipment—reclaimers and stackers—will be extremely important to the Syncrude project. The machines are designed in Germany and represent the latest technical standard.

With the decision to manufacture a substantial portion of the machines in Alberta, GWS Krupp is gaining valuable experience in the fabrication of this type of equipment.

*A bucketwheel excavator operating in Germany*

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# New Syncrude offices

A permanent home has been found for Syncrude's 500 Edmonton employees. Currently they are working out of offices in the north and south towers of Petroleum Plaza as well as several floors of the Financial Building.

New headquarters will be the uppermost eight floors of the north Daon Tower, now under construction, which bears the working title, Seventh Street Plaza.

Murray Campbell, administrator for Office Services for Syncrude, is hoping their new accommodation will provide a little more elbow room.

"No matter how carefully you plan, however, you either wind up with too much or too little; but we have an agreement with Daon which allows us to lease contiguous floors should the need arise. The basic idea was to acquire suitable space and consolidate everyone under one roof."

People planning for the new building prompted Campbell to issue assessments and questionnaires to all employees.

"It gave everyone the opportunity to speak his piece and I got a large amount of interesting and important feedback."

One floor, designated as management, will have a meeting room for sessions held by representatives of the three levels of government and the three oil companies that constitute the Syncrude owners hold once a month.

Also on this floor will be the law library and vault for sensitive contractual information.

It is intended that the Office Services department, which now numbers 18, will be expanded in the new building to incorporate copy centres, steno pools and mail service.

"No two hours are ever alike but they are all interesting and challenging," says Campbell.

Functions under his administration include central filing, a reproduction centre, communications, travel and reservations, office space allocation, furniture and equipment acquisition, parking, budget preparation, handymen and stationary.

In addition he exercises maximum control over long distance telephone calls, and he is also responsible for security and fire protection.

"Our portion of the building will comprise around 105,000 square feet and Hoffman and Associates have been hired as space designers. They are using demountable partitions and space dividers — a sort of mix of traditional and newer techniques. Clerical personnel will be placed around the perimeter of the floors along with top management and directors. In this way the main traffic area will be around the central core.

"Another feature will be two seven-foot diameter skylights over the reception area on the 14th floor. Emergency lighting is planned for the stairwells in case of power failure and evacuation occur at the same time."

Ever energy conscious, the company is having photo-electric cells placed in the interior perimeters of their offices so that on sunny days, or when outside light is sufficient, the overhead lamps are automatically switched off.

"We have been thinking about time switches, to turn lights out when people forget. It would have an overide switch, because no-one likes to sit in the dark with their work unfinished, and at the moment we have security people to look after that."

The tower will contain, at its base, a bank, restaurant, lounge and cafeteria.

"We would like to have some kind of facility installed so our employees would have an opportunity for lunch-hour exercise. Also we've been considering a type of medical facility, something like a nurses' station, for small emergencies that are liable to occur from time to time."


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# 500,000 tons on highway 63

## "Every move a challenge in itself"

*The Grant McEwan and the newly-constructed bridges spanning the Athabasca River*

For a variety of reasons, the soil surface and sub-base of Alberta's rolling parklands and prairie are relatively unstable in consistency and behaviour.

It is not the easiest place in the world to build roads, and the province's road system has been described as "ribbons of blacktop stretched across an ocean of plasticene"

Asphalt pavement is the order of the day, due to a combination of economic factors, availability, and the material's inbuilt flexness which permits it to conform to the movement of the land surface, especially during volatile seasons.

Asphalt provides what is virtually a floating and flexible right of way for the passing traffic. But it can be easily damaged, especially during the softness of spring thaw, by excessive weight and stress.

Highway 63, running north from Edmonton to Fort McMurray and Mildred Lake, is no exception to this provincial perplexity.

Yet, for the past two years or more, vast numbers of massively loaded trucks and tractor-trailer combinations have moved up that highway in one of the lesser-known success stories associated with the Mildred Lake Syncrude project.

No-one has made an exact count, but it is estimated that more than 500,000 tons of stores, equipment, vessels, and plant components have travelled Highway 63 heading north. Similarly, no-one has computed the number of individual truckloads in total, and no-one knows the millions of ton-miles covered.

True, thousands of trucks were within the provincial legal load limits — 65 feet long, 8½ feet wide, 13½ feet high. But hundreds, maybe thousands, were overloads in excessive weight or dimensions.

For each one of these overloads, an individual plan of operation had to be drawn up, with input from the fabricator or vendor, the managing contractor Canadian Bechtel, Alberta Transportation, the police forces through whose bailiwicks the trucks trundled, CNCP Telecommunications, telephone and power companies.

"Every move is a challenge in itself," said Mike Myshak of Premay Equipment Ltd., an Edmonton trucking company which claims to have carried 2,600 vehicle loads north, including some of the heaviest.

Of these 2,600 loads, Myshak estimates that one in six was over-dimensional in weight, height or width.

The mechanics of moving these over-dimensional loads has now settled down to a standard procedure. A blueprint of the unit or load to be carried is supplied by the vendor or Canadian Bechtel to the carrier. He scans it and makes his plans for the vehicle or combination of vehicles required to carry the load safely.

In the case of Premay, the company's fleet of two dozen vehicles can be arranged in about 100 tractor-trailer combinations.

A blueprint and sketch of the planned method of transportation are submitted to Alberta Transportation for road clearance and approval.

"The vehicles have become old friends," said Jack Baynes, a key man at Alberta Transportation in approving or adjusting vehicle load distribution.

"Weight on an axle is the key factor in Alberta," he said. "Too much weight on one axle is what causes road damage."

For example, 10,000 lbs on a single axle, with two wheels to the axle, will cause the same road damage as 35,000 lbs. carried on a set of tandem axles, with four wheels to each axle.

(In this context, the province is working towards the introduction, probably later this year, of axle-weight as the standard measure for allowable vehicle loads, replacing the existing system under which the load-carrying capacity of roads is differentiated by gross vehicle weight (tare plus load) only.)

"Our task at Alberta Transportation is to ensure that axle weights and centres of gravity are correctly applied. Sometimes this means asking carriers to redesign the manner in which they intend to load a vehicle or vehicle combination, adding in ponies or spacers, attaching end boosters, or using vehicles with more axles and wheels," said Baynes.

Concurrently, the load has to be checked for width and height.

The general width of Highway 63 is 28 feet, and there has been more than one occasion when this has caused problems. "In addition," said Frank Macnamera, Canadian Bechtel's procurement manager, "there are approximately 300 wires strung across the highway between Edmonton and Mildred Lake.

"For any load exceeding the regular height limits of 13½ feet, and likely to hit a wire, arrangements have to be made for appropriate crews from the telephone, power or tele-communications companies to be on hand at the right time to lift or adjust wires a load cannot get under."

Added Ken Kobi, Canadian Bechtel's traffic supervisor; "Wide loads move in daylight hours only, and none move on Friday or Sunday afternoons due to the flood of car traffic leaving and returning to the construction site before and after the weekends.

"The heaviest loads had to be scheduled to be moved in the winter, when the gound is rock hard and the road damage factor is less relevent."

Worst period for movement is the spring thaw, when the province automatically places bans on certain roads and decrees that axle-weights be reduced.

Normally, these spring bans apply from early April to mid-July. However, the past two winters, the early spring weather has pulled the frost out of the ground several weeks ahead of the norm, and spring bans have gone into effect as early as mid-February.

But, spring or winter, thaw or frost, bridges remain a critical factor. There are 18 between Edmonton and Mildred Lake, and each one has to be checked out against an overweight load.

When all decisions on load distribution and clearances have been made, the police are called in to provide escorts when necessary. Pilot cars also travel fore and aft the vehicle or vehicles.

"We have run vehicles in convoy to reduce the number of pilot cars and limit road interference to other traffic," said Myshak. Even so, one recent day, Premay shipped 21 trucks north, using 10 pilot cars.


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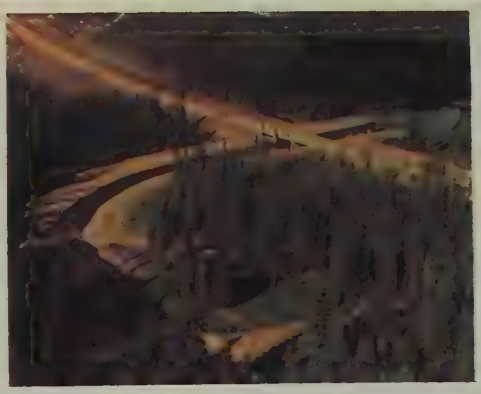
*Poplar Creek spillway — now revegetated with grass*



*Poplar Creek just below the spillway*

*The Meteorological Station with the giant cokers in the background*

# Returning nature to her own

## Abiding pre-occupation with the environment

**"Syncrude Canada Ltd. works with the conviction that human use of the environment need not be destructive. With careful planning, based upon good information, man-altered and natural ecosystems can exist in harmony. In order to accomplish this planning, Syncrude considers resource development from a total-systems point of view. This comprehensive approach corrects the frequent tendency to attempt resolution of problems on a single purpose basis. The total-systems analysis approach leads to a plan of operations using the best practicable technology, both in resource development and in environmental protection. An ecosystem approach to resource development, an integral part of our approach implies an understanding of and respect for the potential of natural systems and the use of the economy of nature, wherever possible.**

**"Through a comprehensive program of surveillance of the effects of our technology and careful application of that technology, we aim to prevent accidental damage to the environment. Total effects will be examined by professional ecologists and study results provided to public representatives."**

**Policy statement by Syncrude Canada Ltd.**

The production of synthetic crude oil is far from being the whole story of Syncrude's operations in the Athabasca Tar Sands.

Briefly put, Syncrude is spending $300 million on environmental research and pollution control, and in fact its network of production processes is interlaced with pre-cautionary systems whose purposes are entirely ecological.

Indeed, in time terms, Syncrude's environmental story is almost as long as its production story.

Initial environmental work was begun in 1962. It centred on broad, baseline studies of soil, vegetation and the animal populations, and on atmospheric and metereological patterns. Since that time, during which the emphasis has shifted from assessments of possible impacts of the industrial projects to studies of the actual effects, the company has spent millions of dollars on environmental research, land reclamation and preventive measures.

In addition to this company expenditure, the federal and Alberta governments, who have established close relation-ships for research into the environmental aspects of Tar Sands development, are jointly funding a 10-year $40 million study.

Both governments, too, have set stringent guide-lines in accordance with the federal Migratory Birds Protection Act and the Navigable Waters Protec-tion Act, the Alberta Clean Air and Water Acts and the Land Surface Conservation Act, and the provincial Department of the Environ-ment has also prescribed a procedure for assessing environmental impact. Over and above all this, Alberta demands a 3c. a barrel bond each year which Syncrude could forfeit if, at the end of the 25-year mine life, the company fails to reclaim the land under the provisions of an undertaking already filed with the Department of the Environment.

Also in the foreground of the environmental picture is the Oil Sands Environmental Study Group, an organization formed in 1973 of 19 tar sands operators and leaseholders. In return for their support of the study project, participating members will receive the results of the study as an aid in formulating their own reclamation plans.

Syncrude is one of the participants, and for its part, because of its physical impact on the area, its specialized knowledge and its well-established environmental research programming, is playing a key role not only through its own active measures but in sharing its knowledge with all other people involved — including private activist groups. "There is now more willingness to share information, and there is much more openness than there ever was inthe past," comments Dr. Ron Goforth, Syncrude's director of Environmental Affairs. "We are putting our information out, notably into all kinds of scientific literature, at a phenomenal rate."

Ever since the incep-tion of its environmental work all those years ago the company's programs have had four major objectives as guidelines: to determine the conditions prevailing in the area before any disturbance occurred; to monitor the effects of construction and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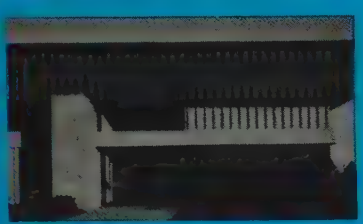

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ration of the plant on the environment; to plan and conduct the research necessary to ensure successful reclamation and revegetation, and to be constantly aware of, and able to respond to, any possible changes that were not anticipated.

Three years before the start of construction a team of environmental personnel was built up within the company to provide expert, professional input into company decisions. This team has included experienced botanists, zoologists, ecologists, geographers, chemists and environmental engineers and technicians. Outside consultants have also been contracted to conduct ornithological, aquatic biological, entomological and climatological research; soil scientists at the University of Alberta are working in co-operation with the Alberta Department of Agriculture on soil and vegetation studies.

### Vegetation

On broad lines the Syncrude environmentalists and their consultants have been, and to an increasing extent are still, concerned with vegetation — and, with it, revegetation and reclamation — wildlife, and the effects of emissions on air quality.

Over the past 10 years Syncrude environmentalists have catalogued plant species within a wide radius of the project, and one of the most intensive — if not unique — studies ever undertaken by industry has been carried out on the effects of sulphur dioxide, the principal culprit among the emissions, on lichens, a living combination of algae and fungus which take their nourishment from the air and consequently show signs of damage or deterioration before any other form of vegetation. During the summer of 1976 no less than 56 lichen monitoring plots, radiating in eight lines up to 35 miles from the Syncrude plant, were set up. Within each of these plots 10 to 20 trees were tagged and the lichens photographed, and over the next 30 years more photographs and samples will be taken periodically and checked against the originals.

This study is being augmented by a chemical and electronic monitoring system around the site, whereby five stations equipped with NASA-designed telemetry to monitor hydrogen sulphide and sulphur dioxide will be backed up by 40 static air monitors that absorb sulphur from the atmosphere.

The revegetation of some areas around the project that were disturbed by construction is already underway, with 350 acres seeded last year alone. Helicopters were used to seed flat areas and tanker trucks, equipped with sprayers, hydroseeded steeper slopes. These tanker trucks pump a mixture of water, seed, fertilizer and mulch through a hose on to the area being treated. The seed mixtures were chosen to provide fast-rooting and suitable forage for wildlife, and fertilizers were also applied in a concentration double that used by the provincial Forestry Service.

An example of this revegetation policy is provided by the Beaver Creek diversion area.

Beaver Creek used to flow right through the mine and plant sites, and in 1975 was dammed and diverted away into the Poplar Creek drainage system. The diversion was planned to minimize damage to the environment, a concrete spillway being constructed to carry the increased flow of water from the top of the original escarpment down to Poplar Creek without erosion. The lower part of the spillway was designed to slow the water to a speed similar to that of Poplar Creek in order to reduce possible disturbance of the creek bed. The steep slopes beside the spillway were completely denuded of vegetation as a result of construction operations, but by June of last year the reseeding program had covered the bare soil, over an area of some 170 acres, with a mixture of legume and grass seeds fertilizer and mulch.

As a longer-range goal, the company is to revegetate the 10 square miles of minesite surface once the area is mined out.

In a plan to make use of natural materials removed during construction and mining, more than five million cubic yards of muskeg have already been stored around the mine site ready for replacing, and the peat from the muskeg will be worked into the sand to provide a topsoil, after which grass seed and fertilizer will be applied prior to planting a mixed forest of pine, spruce and aspen.

### Animal life not endangered

In the meantime, over the past three years, studies have also been carried out on the various forms of wildlife in the tar sands area and many species of birds, fish, animals and insects have been catalogued. While the animal life is not endangered by the operations, it has to adjust to the loss of many square miles of habitat.

Fish are not affected. No process water is drained into the Athabasca River and less than 1.5 per cent of the river flow is required for plant operations. Any mine drainage water entering the river is carefully monitored to avoid damage to fish.

The habitat scenario, however, is not without problems.

A wide variety of birds utilize the region for migration stopovers, breeding, nesting and moulting. Development of the area could eliminate favourable habitat, both aquatic and terrestrial, and establish unfavourable habitats, particularly aquatic, that could prove to be attractive and hazardous. The most serious problem which could be created is possible oiling of birds landing on a "tailings pond", the area into which effluents from the process will be discharged. This body of water could remain open when others are frozen over and might therefore attract waterfowl.

In recognition of the potential hazards of the tailings pond, Syncrude is conducting research into three separate aspects of the problem: to improve the efficiency of the separation process, thereby decreasing the amount of bitumen discharged to the tailings pond; to improve methods to contain within a small area of the pond any bitumen which is discharged; and to develop deterrents which will prevent birds from landing on the pond.

The region of tar sand development has some areas of favourable habitat for fur-bearing animals, and moose and deer. Construction of tar sand plants entails clearance of vegetation and consequent changes in habitat and altered surface hydrology. To counter this impact, studies are being undertaken to determine the extent of the disturbance and to develop reclamation and revegetation plans to encourage the re-establishment of displaced animal populations.

### Minimizing emission levels

One of the most important aspects of environmental considerations is the degree of air pollution resulting, to some degree to an imponderable extent, from the production of large volumes of sulphur dioxide, carbon dioxide and nitrogen oxides — not to mention steam. The plant has been designed with the minimizing of emission levels and the maximizing of dispersion in mind — including, most visibly dominating the skyline a 600-foot stack whose height was determined by computer programming which estimated how much sulphur dioxide would diffuse back to ground level — and the company has an environmental laboratory on the site which, among other functions, monitors surface water quality and air quality and operates a meteorological station to provide immediate chemical and physical baseline information.

A year-long study by a firm of consultants concluded that the Syncrude plant should meet environmental standards 99.3 per cent of the time, and even though on occasion the surrounding vegetation might be subjected to concentrations of sulphur dioxide, some of the soils in that area are deficient in the chemical anyway.

Four oil companies currently holding leases in the Alberta tar sands area — in addition to Syncrude they are Shell, Home and Petrofina — are involved in intensive climatology studies. Weather ballons, released five times a day from the Syncrude site, monitor wind speeds, direction and temperatures, some being specially equipped to transmit information on temperatures to the field laboratory. This information enables observers to predict the occurrence, frequency and duration of those periods when stack emissions may be most likely to exceed air quality standards and to warn the operations people accordingly so that avoiding action can be taken wherever possible.


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# The tar sands and Canada's energy strategy

*Written for Construction Alberta News by James Gillies M.P., Progressive Conservative Energy Critic in the Federal Parliament*

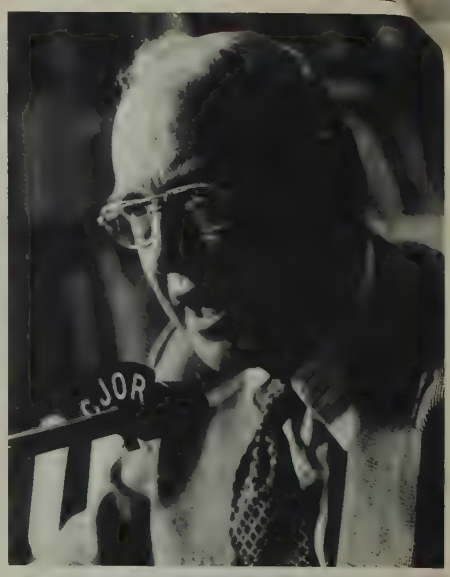
The development of the OPEC cartel has forced every major country in the world to re-evaluate its energy policies. Regardless of the resources available, whether in great or little supply, the restructuring of oil prices by the cartel and the possibility of limiting supply has meant that no country has been able to consider its energy policies since 1973 in the same way it did before the cartel acted. Indeed, overnight, countries that believed their economies would operate into the foreseeable future on the basis of low priced energy, have had to face the fact that such was no longer the case—and indeed that there was a very real possibility that they could be totally shut off from any supply of oil at all.

The re-evaluation of energy policy in Canada has been particularly extensive, and in many ways painful primarily because Canadian oil policy through the 1960's was based on the assumption that Canada had unlimited reserves of natural gas and oil, and therefore had little to fear from restriction of output by foreign suppliers. The realization of the total falsity of this basic assumption, plus the new world situation, created the need for changes in the country's oil strategy and these changes were outlined in a report issued by the government in 1976 entitled AN ENERGY STRATEGY FOR CANADA: POLICIES FOR SELF RELIANCE.

The essential element of the new strategy was that Canada should not attempt to be self-sufficient in oil. This is a far cry from the policy of the 1960's and early 1970's when the strategy was to be a net exporter of oil and to look for markets. The reality is, however, that in 1977 Canada will be a net importer of oil to the extent of 240,000 barrels per day, and it is forecast that by 1989, imports could amount to approximately 1 million barrels per day or about 45 per cent of all consumption. It is the government's objective to reduce this dependence on net imports to about one-third of all domestic demand or 600 million barrels per day by 1985. This goal is to be achieved by increasing the output of the Canadian oil industry by substitution of other forms of energy for oil, and by conservation.

A vast number of assumptions, and a great deal of analysis, both with respect to the supply of, and demand for, oil underlie this strategy. It is proposed that Canadian oil prices will be equivalent to those prevailing throughout the world, that frontier oil will be discovered and be flowing to the market at the rate of 250,000 barrels per day by 1986 and that output from established areas will be declining. Demand for oil, assuming world prices, is expected to increase at a 3.4 per cent average annual rate. The difference between demand and supply will be made up by imports.

The role played by the tar sands in this policy is assumed to be extremely modest. It is planned that by 1985, total output from this important potential source of oil will be about 275,000 barrels per day, a target which, given the present situation, seems optimistic. New developments in the tar sands are considered to be only marginally attractive at international oil prices and so only one additional plant beyond Syncrude is forecast to be in operation by the mid-1980's.



Does this energy strategy — in terms of oil — make sense for Canada and, indeed, for the world?

By almost every standard, it is clear that the policy is singularly unimaginative and deficient. In a world where oil is scarce in relation to demand, Canada has one of the greatest potentials for oil development of any nation. The tar sands of northeastern Alberta and part of Saskatchewan cover 19,000 square miles and the amount of oil contained within these sands probably exceeds 900 billion barrels compared with known world reserves of conventional crude oil of 666 billion barrels. For a country with such reserves to plan its oil strategy on the basis of limiting imports to one-third of domestic needs, is incredible.

It is, however, one thing to have oil potential and quite another for it to be economic to develop that potential. To date, the costs of extracting oil from the tar sands have been very high and the pioneering company in the oil sands — The Great Canadian Oil Sands Ltd. — through most of its history has been a major money loser. It is only since the world price of oil has escalated, in response to the OPEC cartelization, that possibilities for a rate of return sufficient to induce investment, has been foreseen. Because of the relatively low rates of return and the very high amounts of investment involved in development of tar sands oil, it is not astonishing that private capital has been somewhat reluctant to speed up their utilization. Indeed, the escalation of costs, as a result of high rates of inflation, nearly led to the demise of the Syncrude project and if the federal government and the governments of Alberta and Ontario had not agreed to participate in the project, it might well have been discontinued. The plans of Shell Oil to follow in the tar sands with a third plant have been dropped because of the magnitude of the investments required — nearly $3 billion at current prices — and the uncertainty of possible earnings.

Thus there is a dilemma. Canada has the potential for producing great amounts of oil but the economic framework for making it feasible to produce it has not been put in place — and there are those who feel that oil from the sands simply cannot be obtained in an economic fashion in the foreseeable future. However, there may be considerable overestimation of how difficult it is to find an economic regime which will make such development possible. To keep perspective it should be noted that with an investment of $2.5 billion, Syncrude will supply 60 per cent as many B.T.U.s to Canadian markets as an Arctic gas pipeline which may cost three times as much. This is not to say that a pipeline may not be necessary, but it does argue the need of keeping priorities straight. A top priority must be the development of the rich potential of the tar sands because Canada needs the foreign exchange earnings which accumulate from the sale of oil abroad, and conversely, given its current position in the world of economy, cannot afford to use its limited foreign exchange earnings to buy a resource which it has in ample supply within its boundaries. Moreover, in a world of potential energy shortages, it is immoral for a country with possibly the greatest reserves of oil of any nation in the world not to produce it.

How can the dilemma be resolved?

Basically, the answer is through the government doing what a government should do and not doing what a government in a free society should not do. There is no reason for the government to be heavily involved in the oil production business. Experience has demonstrated that by and large governments are not efficient and effective operators of enterprises. But it is the responsibility of government to create a climate whereby massive investment is induced in the oil sands. The most important function of a government is to create a stable financial environment where the guidelines, pricing policies and tax structures are clearly spelled out so that investors in the oil sands know that they are operating in a climate of certainty with the possibilities for a competitive rate of return on their investment.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# Tight rein in environmental control

*"It is not fair to suggest that industry is raping the north," says Dave Russell, Environment Minister, Government of Alberta*

Any suggestion that industry is running roughshod over northern Alberta is likely to be met with strong opposition from Alberta's environment minister, Dave Russell.

"Even though we recognize there are some important unsolved problems, it certainly wouldn't be fair to suggest that industry is raping the north."

Russell points out that, in the case of oil sands developments — a subject that has raised more concern among environmentally-conscious Albertans than most industrial undertakings in the province — controls are among the tightest being exercised in any industry sector.

Since the provincial department of the environment has been in existence for only six years, it has literally grown up with oil sands development and in particular with the Syncrude project.

"You really can't treat a tar sands plant as a typical industry — and requirements as far as environmental protection are concerned have been pretty comprehensive."

If oil sands operations are less affected by a promised tightening up of environmental controls (Russell predicts a new "tougher" approach to enforcement involving "more control orders, stop orders and prosecutions"), it is only because they're already been subjected to closer scrutiny than some long-established Alberta industries.

According to Russell, the day of reckoning is almost certainly at hand for the roughly 10 per cent of Alberta industries that consistently fail to operate within accepted environmental guidelines. Included in this group are some firms in the pulp and paper, cement, meatpacking and feedlot industries, he observed.

"After six years, we're entering an era in which we're going to be stiffer about enforcing regulations. There's some indication we may not have been tough enough in the past."

With respect to tar sands development, Russell feels problems related to sulpher dioxide emissions and tailings ponds are the most pressing. However, on the positive side, he feels it is important to stress that tar sands plants are much cleaner than comparable industries. "It would take six Syncrude plants to equal the emissions of sulphur dioxide created by one Inco, for example."

By writing safeguards into the Syncrude agreement, the government has made every effort to provide for obvious concerns, the minister says. This includes making provision for guaranteed reclamation work and ensuring that soiling of the environment is kept within accepted provincial standards. When it comes to potential problems, however, it was decided that additional work would be worthwhile — not only in the interests of the province but as a contribution to national environmental programs. This attitude led to launching of the 10-year, $40-million Oil Sands Environmental Research Program (OSERP), being funded jointly by the Alberta and federal governments.

Alberta's contribution last year was $2.5 million. This year it is $2 million — but the lower estimate does not reflect any slowdown in the program, Russell notes. The extra money in last year's budget was to cover costs of setting up the program and establishing camp headquarters. Alberta's contribution will average $2 million yearly during the 10-year period in which governments, consulting companies and universities will co-operate on research related to the total field of oil sands environmental protection. Projects will encompass research into air quality, vegetation, aquatic and terrestrial animal life, human environment, land use, groundwater and surface water.

Industry too is involved through the Oil Sands Environmental Study Group (OSESG) which co-operated in the planning of the program.

The government research effort, being co-ordinated through the environment department, is not designed to replace research work being done by individual leaseholders such as Syncrude, who are members of OSESG. Rather, it's concerned with the overall aspects of environmental planning and protection for the total area.

Although Russell admits "that's a lot of money to funnel into oil sands research alone", he is generally satisfied with the program. The size of the project can be judged by the fact that the money earmarked for oil sands research this year accounts for roughly two-thirds of the total $3.1-million environmental research budget.

Russell says the OSERP program has been criticized in some quarters for being too academically-oriented. "We're now looking at this — but in defence of the present approach, it's obvious that if Alberta and Canadian universities are the agencies that can best provide the services we're looking for, they should be participating."

Despite some pressure from environmental action groups such as Save Tomorrow Oppose Pollution (STOP), for public hearings focusing on tar sands development, the environment minister insists such meetings would be less than effective if held before some baseline data is presented by OSERP. "Once this information is available, we would probably schedule hearings through the Environment Conservation Authority."

Commenting that there is more to public hearings than a particular company selling its point of view, Russell continued: "You need a well-informed public coming forward to state objections and raise questions. Without some non-arguable baseline data — which we don't have yet — this would be impossible."

In the meantime, the department is involved in "a fair amount of monitoring in the tar sands, watching and working with groups such as STOP and with the town board of Fort McMurray."

Russell noted that, of several charges levelled at GCOS under the Clean Air Act of Alberta and the Clean Water Act, three are being appealed. "We're in the process of reviewing and testing current legislation — with a view to making it tougher if necessary."

Rapidly advancing technology is well on the way to solving some of the major problems originally envisaged in tar sands development, he claims. Concerns over excessive $SO_2$ emissions, for example, will diminish in future with vastly improved pollution control devices now coming on the market. "We're satisfied with the steps being taken now to control emissions and there is evidence these measures will improve with every subsequent tar sands plant that comes on stream — since equipment has become more efficient even since approval was announced for Syncrude."

He believes the most critical environmental problem, now awaiting solution in the tar sands involves tailings disposal Even tailings ponds created in strict compliance with environmental regulations "simply can't go on for ever," he contends.


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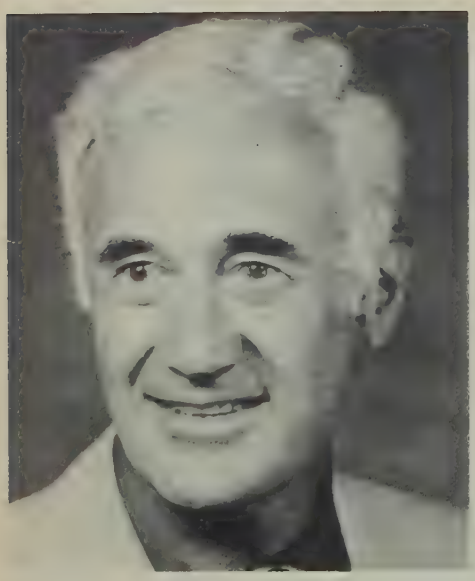

R.V. (Vic) Henning

# The people problems

## Coping with problems of industrial development

As a personal view I would anticipate more surface mining plants like Syncrude. I have no particular thoughts about timing, but I would expect more than one before the in situ techniques reach the point where they will become our main source of bitumen."

This was the opinion expressed by R.V. (Vic) Henning, Commissioner for North-east Alberta, in a talk with Construction Alberta News.

If and when a decision was made to establish a new plant in the area an important concommitant decision would have to be reached as to who will administer the area — whether it will be Fort McMurray or a new town — and that decision would determine whether his Commission would continue as it was or in a different form or be replaced by a different agency. "My view is that it has worked quite well, though it has not always been easy."

Following the oil crisis of 1973 there was an impetus to develop the tar sands, and "all sorts of scenarios were being thrown about projecting one new Syncrude plant every year for I don't know how many years."

Whatever industrial development might be foreshadowed, however, there was at that time no kind of regional or overall planning to provide a framework for the future development of the area to be conducted in an orderly fashion. The impact of Syncrude was already being felt on the infrastructure of Fort McMurray and the surrounding region, and it highlighted an urgent need for housing, schools, social services and the like. This office had been set up in 1974.

Henning went on to explain that his functions were to initiate or organize the development of plans and programs for the provision of municipal, education, health, transportation, communication and other public services for the residents of the region. In addition he was charged with co-ordinating programs and services and administrative procedures of government departments and agencies and those local authorities with jurisdiction in the area.

"The thing that attracted me to the job," he went on, "was the distinct possibility that bureaucracies could be co-ordinated, and I set out to do just that on a basis of co-operation with all the departments and local authorities involved. What I said to them in effect was that I had no wish to be involved in doing their job for them but that I would appreciate it if they were to keep me informed — and I, in my turn, would keep them informed.

"It has worked very well, and we have certainly not lived up to accusations that we would be building up just another new bureaucracy.

"My involvement has been one of providing an outstretched hand. I have the ability to get to people in the government in a hurry and in a way that avoids tortuous routes. In the case of all the boards and agencies we have had a pretty close relationship. All our problems are not solved, but they are well on the way."

His primary concern was with people problems, and he was particularly involved with the effect of industrial development on the Native peoples. The switch to industry and the need for special skills could overwhelm the indigenous people, but that was not to say that they were not important, and the best solution to these problems was to help them to help themselves.

"Hopefully, one can act as a catalyst and find the right answers. I think a lot of Native people would like to be partners in a meaningful way and in a way that will not disturb their lifestyles."

It was a condition of the Syncrude leasing that the company should provide employment for Native people, and the company kept statistics on it. The Native people might not be entirely satisfied with what had been done so far, but nevertheless a very big step has been taken in the right direction.

# Need for personnel

## "Hoping to overcome shortages"

Syncrude is seeking qualified personnel to fill approximately 2,500 positions on its permanent workforce by 1981.

"The recruitment program began with three basic commitments," Dave Simmonds told Construction Alberta News. "Number one being that, since it is an all-Canadian company, preference should be given to Canadians. Secondly, since the project is located in Alberta, priority should be granted to Albertans. Number three is the public commitment to the native people in accordance with the Indian Employment Opportunities Agreement."

A major endeavor is being made to acquaint people with the right kind of skills about the jobs available.

"Most effective to that end," said Simmonds, "has been career and classified advertising in newspapers and trade journals. We also make our needs known through manpower centres and television commercials."

Brochures have been prepared and printed for distribution to show where a particular training and experience will fit into the overall picture of positions available.

This advertising is done on a Canada-wide scale and Alberta's two main virtues, that of the lowest provincial income tax in Canada and no provincial sales tax, are not the least of the drawing cards offered.

Personnel shortages the company is hoping to overcome, according to Simmonds, fall among technical graduates such as auditors, systems people, cost engineers and employee relations specialists. Next are non-professional occupational people such as electricians and millwrights, process operators and heavy duty mechanics.

In response to advertising Simmonds says, "We get a lot of paper which has to be evaluated to determine the qualifications of potential employees."

The Syncrude project offers a major opportunity for Canadian engineers, consultants, researchers and people in various petroleum technologies to gain experience and expertise in the new technologies related to the tar sands.

This know-how will remain in Canada, available for future tar sands developments long after the Syncrude project is complete. At present white and native residents of north-eastern Alberta, many of whom are unskilled and have been only seasonably employed, are being provided with an opportunity for training and employment during the project's construction and operation.

Native involvement in the project is on the increase with Syncrude maximizing efforts to hire those who possess the necessary job skills, and letters of intent to hire are given to those who desire to up-grade their training and qualifications.

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# "A never-ending thing"

## Purchasing everything from machines to seeds

Anyone who can't remember four items between home and the corner grocery store would find Cam McDougall's job with Syncrude a little more than mind-boggling.

McDougall has been assigned the role of procurement co-ordinator to monitor Bechtel's activities and set up a purchasing structure for the future when the on-stream plant is turned over to Syncrude.

It was decided to develop a purchasing organization that would be viable, with the central core in Edmonton, the object being to locate the department closer to vendor ties and achieve a closer scrutiny of capital expenditures.

A local purchasing department will also be set up in Fort McMurray to handle daily repair items and small parts available in the area.

"Right now we are ordering a lot of vehicles and mobile equipment such as tractors, dozers, vehicles for servicing and eight large haul trucks each with 80 to 85 cubic yard capacity. In addition we have on order parts for draglines, bucket wheels, pumps, turbines and compressors.

"Four draglines have been purchased and we have two more on order. Based on production of 125,000 plus barrels per day, we'll need six when we are fully operational.

### Extensive inventory

"We had to place our order in 1974 to insure 1980 delivery because there are only two companies making them, Marion Power Shovel in Marion Ohio, and Bucyrus Erie in Milwaukee, Wisconsin," explained McDougall

The purchasing department is concentrating largely, at this time on building up an extensive inventory of spare parts and bulk material from pipe, fittings and valves down to nuts and bolts.

Parts are being ordered for original equipment, some of which come from Germany, Italy and England, to insure that no work interuptions or delays are caused because of lack of replacements.

"We have ordered a great many tools, machine shop equipment such as lathes and boring tools, hand tools and related equipment in excess of $1 million," says McDougall. "Metrication will probably cause a few fits but our machine shop will be second to none in Western Canada. Every conceivable thing that could possibly be needed will be put into inventory and warehoused at the plant site."

Different types of catalyst for the up-grading facilities have been ordered well in advance, with some scheduled for delivery later this year.

Once the plant goes into production there will be de-bottle-necking adjustments which will, no doubt, require items that cannot now be foreseen.

Purchasing also handles contracts — consulting agreements for on-going environmental work, which is a continuous process, and also for environmental purposes, is the equipment for air-monitoring stations, also on the department's inventory.

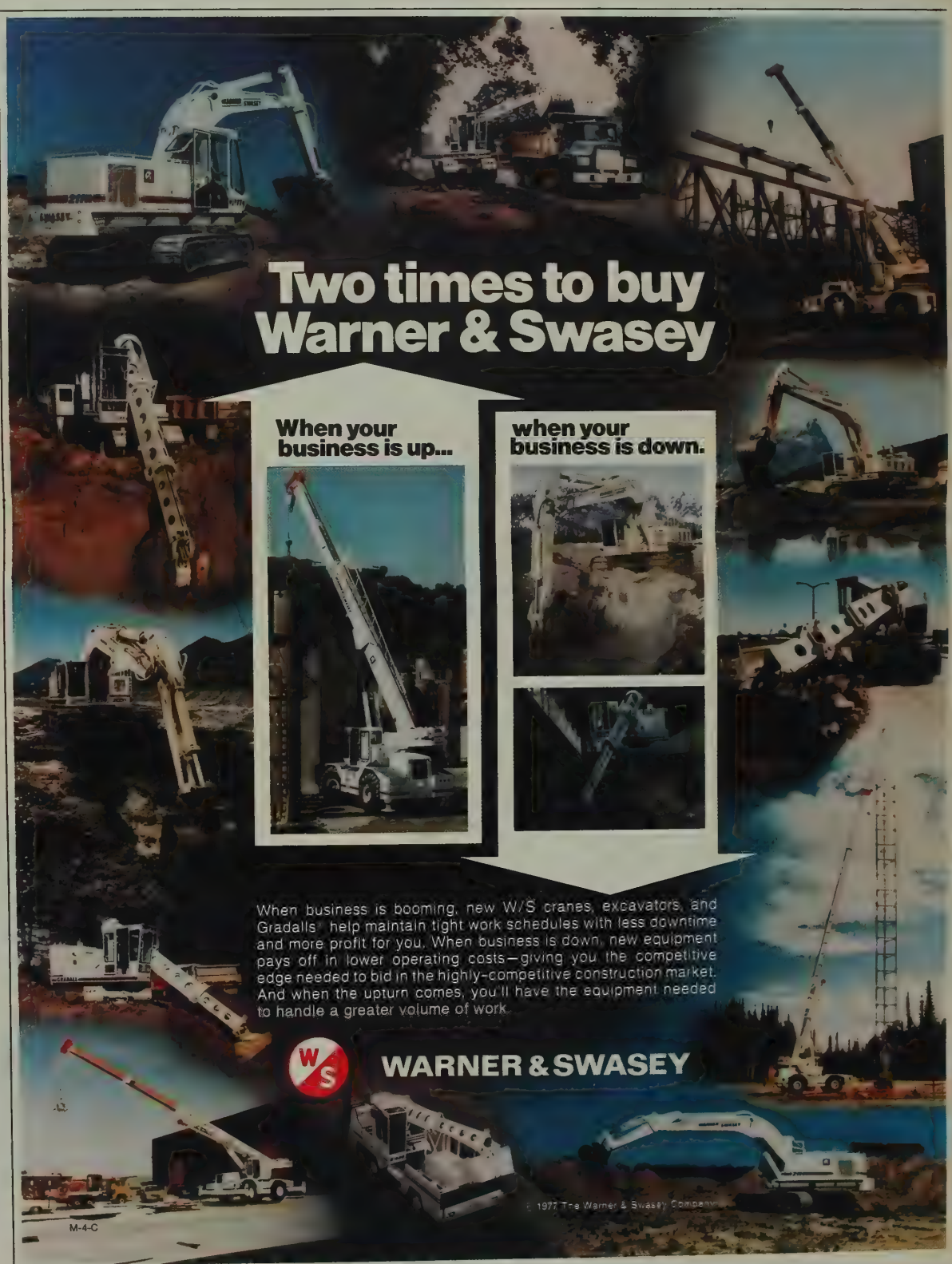
Special types and mixtures of seeds and seedlings are being bought for the company's re-vegetation projects.

"We're into everything from paper clips on up," comments McDougall. "We're buying all types of safety equipment such as ambulances and fire extinguishers of all sizes; also training aids, instrumentation not basically covered in the original contract, plus office equipment, desks, calculators and copying machines for the rapidly expanding number of employees.

"Teaching materials are being purchased to train mobile equipment and plant operators, audio-visual equipment, books and related supplies.

"We have an operations laboratory at the plant site as well as the Edmonton Research Centre for which we are ordering extensive laboratory equipment and supplies.

"It's a never-ending thing, in that whatever gets used up, worn out or broken down must be replaced."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# The team concept.....

## .....in employee relations policy

Outlining its employee relations philosophy, Syncrude has this to say:

"The underlying assumption in establishing an employee relations philosophy is that the work life needs of individual employees are complementary with basic objectives of the company.

"For its part, Syncrude recognizes its human resource as being comprised of all its employees, each to be recognized as an individual with both individual perception and needs. Syncrude believes that each employee has needs for security, acceptance, and respect, and for the opportunity for personal achievement and growth. Further, Syncrude accepts the obligation to maintain a work environment which permits these needs to be met within the pursuit of company objectives.

"At the same time, Syncrude's expectations of employees includes their willingness to work effectively at developing and maintaining commitment to company objectives and interests, and working co-operatively within the organization.

"Syncrude believes that the work environment is influenced by the behaviour of all employees in the organization. To the extent that each employee assumes that others share a desire to do good work, to look for opportunities to accept responsibility and to have the capability to plan, manage, and attain results, then Syncrude will become a more effective organization characterized by openness and trust.

"More specifically, Syncrude expects its supervisors, managers, and indeed all employees to be guided by the following principles:

> To the greatest degree possible, team approaches are to be employed in meeting departmental and company objectives;
> Each employee should understand the nature of his/her job and how it interrelates with others. Beyond this, each should know the standards by which job performance is judged and how he or she is performing against these standards;
> In general terms, supervisors and managers should establish a work environment which recognizes and encourages employees' needs for personal growth and achievement to the limit of their ability. Consistent with this, working relationships should be established to recognize that employees need to be informed and to have ready access to information related to their job, to have opportunities for self-direction, and to participate in decisions affecting their jobs and work environments;
> Each employee's work is deserving of respect and fair compensation, and
> employees have a right to a fair hearing and a timely response to both their suggestions and concerns.

To implement these objectives the company has devised, and is currently putting into effect, a supervisors' training program — "supervisors" in the widest sense of the term from the president to the shop floor — aimed at the achievement of a team concept which can improve the quality of work life for all company people.

As a comprehensive whole, this program is known as "management in sync", commonly referred to as "MIS".

"In effect what we are doing," says Jonno Hanafin who heads the Organizational Effectiveness team responsible for general implementation, "is to assist our people to build teams of employees, on the principle that the whole is greater than the sum of the parts, and to get people to work together in a positive fashion by collaboration and co-operation rather than competing with each orther, and our job is to encourage

people to develop attitudes that are necessary if they are to work together effectively.

"It is also the company's objective to achieve a high level of flexibility among its people. We do not wish to have people who are bored with their jobs; we want instead that they should learn alternative skills and thus be able to rotate with other members of the team, adding to their qualifications, skills and versatility and consequently to their ability to earn more money."

According to Syncrude, the team concept the company has devised is the most efficient way to meet corporate objectives, and the productiveness of all employees will be greater with this approach than with others. Further it gives everyone in Syndrude the opportunity to contribute to the success of the company, and it can be a more productive and rewarding organization if its people can operate in a non-union environment. The primary determinant of whether Syncrude has a union or not will be the way the company manages its people.

The company goes on to point out that the team approach can minimize turnover and absenteeism (which reduce productivity) and make Syncrude a place where people want to work and contribute to the best of their abilities. The continuous development of members' talents and potential will allow them the opportunity to grow and help expand the company's pool of talents.

Implementation takes the form of one-week training courses for supervisors. The objective of the program is to blend the pursuit of company objectives with the work life needs of individual members of Syncrude through effective management using team approaches.

Each week-long management training workshop will begin with a review of the present state of working life at Syncrude. Surveys to identify working relationships have been distributed to all supervisory personnel. Feedback from this is being used in the course.

Next, the workshops will centre on how the team concept should be applied to the Syncrude organization to reach the goals outlined in the company's statement of policy.

Throughout each five-day training session, 32 participating members representing a cross-section of levels from the president through first-line supervisors, learn management team skills as a foundation for developing practical blueprints for putting these approaches into action.

Immediately following the MIS program, training efforts will be concentrated on developing team skills in non-supervisory members. "The meshing of both programs is the vital link in creating effective work teams throughout the company," says Brent Scott, Syncrude's president.

As outlined in the company's policy statement, this team concept is to some extent breaking new ground, but in principle it is neither new nor unique. As an exercise in enlightened employee relations policies, notably in Britain, it dates back to the 1890s and, from time to time since then, there has been some impetus towards it, more particularly since the end of the second world war.

It has been introduced to a limited degree in some companies in Europe, North America and Japan, more especially in those geographical areas where flexibility is allowed in employee relations policies; but generally speaking it has not survived the pressures imposed on it by other philosophies that, sometimes well-intentioned, sometimes mischievously, perpetuate the "us-and-them" concept.

effective on-the-job team management approaches.

Developing team skills is critical to the success of using team approaches to management. These skills include effective two-way communications, group problem-solving and participative decision-making.

Training coaches will work through the week to assist attendees to produce

Syncrude may well be in a unique position, however, in that it is all the start of something new. There are few preconceived ideas; even fewer precedents in its particular field of industry.

If the company is allowed to go it alone, it may well make it. Certainly the determination and all the necessary imaginative planning are there.

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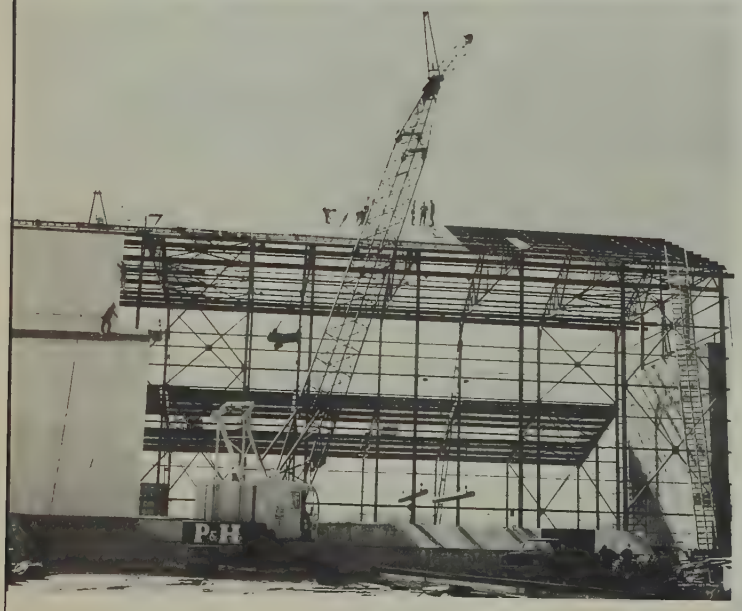


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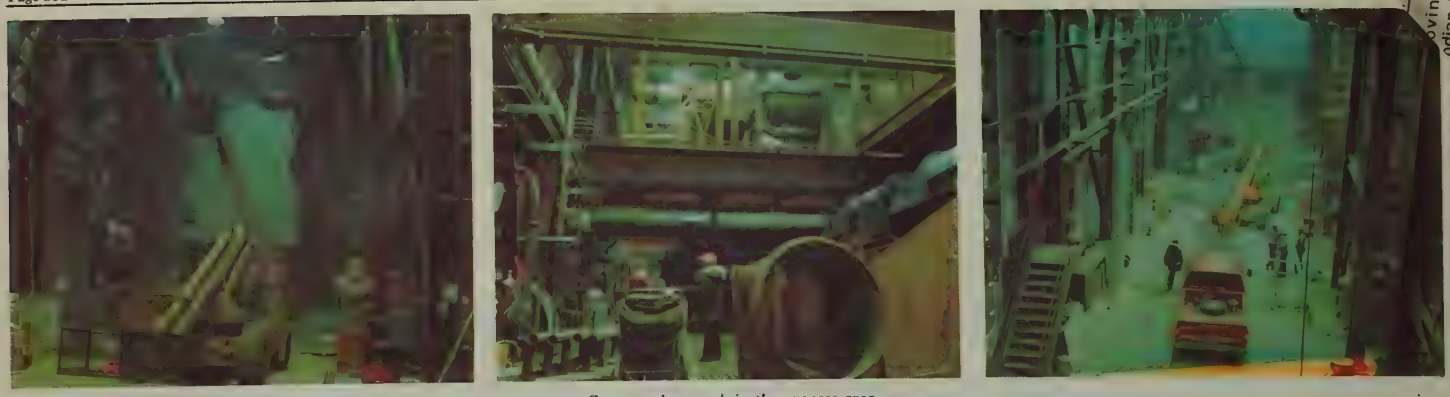

*Construction work in the process area*

# The company and the community

The Syncrude people are under no illusions regarding the impact their vast industrial project is having, and will continue to have, on local communities — notably the Native people of the region and the town of Fort McMurray.

There is not only disturbance — the physical impact of a sudden explosion of heavy industrial and commercial activity in a rural environment; there is the substantial immigration of new, industrially - orientated people; the influx of new money; the inevitable strain on local resources in the provision of amenities and facilities.

The effects of the new industry have been, and will be for some time to come, manifold — some of them superficial, but most of them fundamental, even to changing lifestyles.

Briefly put, the trapper in the oil sands regions can no longer look forward to a lifetime of tending his traps; for the shop on the corner in downtown Fort McMurray a cozy routine is a thing of the past. For good or otherwise — good, certainly, in a national context — the leisurely serenity of a previously remote rurality has been rudely dissipated for the next few decades.

Not, perhaps, that the local communities would necessarily have it otherwise. A higher standard of living and a higher tenor of communal activity and, therefore, more available employment, have been brought within their grasp. But such is human nature that the effects of such sudden economic changes, coupled with equally sudden ecological changes, must be closely monitored, controlled and channelled, and there is therefore an onus of responsibility on somebody. That somebody is inevitably the company — and the government.

## Reconciling human issues

Far from being preoccupied solely with the mechanics of their big operation, the Syncrude management have devoted a great deal of thought, effort, time and money, in co-operation with the federal and Alberta provincial governments, to the reconciliation of human issues that, geographically and environmentally speaking, extend far beyond the plant's boundary fences, and they have clearly recognized, with a social conscience all too evident, that the company's responsibilities are by no means limited to the production of oil.

To take the Native peoples first.

In order to enable the Native people of the region to derive maximum advantage from this new industrial development, Syncrude policy is two-pronged — the first to provide training for actual employment in the plant, and the second to provide assistance to enable them to benefit, by their own enterprise and efforts, from the opportunities spinning-off from the Syncrude project in the areas of service and supply industries.

To fulfill these twin objectives the company has a Native program section which is charged with the provision of social skills counselling to families of Native employees; the provision of cultural orientation instruction to Syncrude supervisory staff, both Native and non-Native; assistance in program development of cultural orientation for Native employees; and maintaining liaison with Native leaders, representatives of the Alberta Indian Association, the federal government's department of Indian and Northern Affairs and Canada Manpower, the Native Secretariat of the


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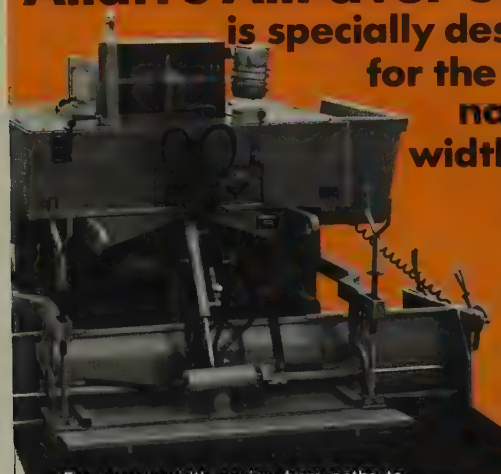

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### $3 million for Indian firms

This company policy activates an agreement signed last summer by Brent Scott, Syncrude's president, Judd Buchanan, federal Minister of Indian Affairs and Northern Development and Harold Cardinal, now Director General of the Alberta Division of Indian Affairs under which Alberta Treaty Indians would receive opportunities for regular employment and business contracts with the Syncrude organization.

A second contract, signed at the same time by Judd Buchanan and Harold Cardinal, provided a minimum of $3 million of federal money to assist Indian-owned firms to become established in the Fort McMurray area.

Togetner, these agreements committed more than $10 million for training and economic development for Alberta Indians.

The first agreement committed Syncrude to offer employment to qualified Indians in all sectors of the company's operations.

Indians lacking Syncrude's educational entry qualifications, but otherwise meeting the company's standards, receive up to two years of pre-employment academic training and up-grading, the cost of which is borne by the federal government through its Department of Manpower and Indian Affairs.

"All three parties to the agreement have been active in the past several years," says Brent Scott, Syncrude president, "in developing programs to improve opportunities for Native people, and the agreement joins these programs together in a public commitment by all the parties to move forward together, and to plan together."

Harold Cardinal comments, "It is only through successful business operations that Indian people will be able to successfully participate in the white society;" while Judd Buchanan expresses the view that the agreements are an example of what can be obtained by joint co-operation between the federal government, Indian people and private businesses. "Syncrude is showing what a large business, which has a strong social conscience and good business sense, can do to ensure that Native people have the opportunity to develop along with northern development."

Today there are about 40 Native people on the permanent staff of Syncrude, while in the construction force the number is nearer 600.

### Plaudits for Canadian Bechtel

It is not only Syncrude, of course, who have made Native involvement a cornerstone of their community policies — and this brings us back to the 600 Native people employed in the construction force.

Canadian Bechtel, the managing contractors for the construction of the plant, with a workforce peaking at over 1700, have similarly committed themselves, and in fact they have been accorded tangible recognition of their efforts by the presentation of the Native Outreach Annual Award for 1976 — Native Outreach being the Native employment agency working with companies, unions and government departments.

"It has been the tradition," the agency records, "that Native Outreach has given recognition to either an individual within a company, a union or a company for extraordinary work done with regard to the employment of Native people.

"During the past year, Native Outreach, in co-operation with Canadian Bechtel and the Labourers Union Local No. 92, has promoted the hiring and training of Native people within the Syncrude site in a manner that guaranteed jobs for the people.

"In addition, the Labour Relations section of Canadian Bechtel, with the co-operation of the various building trades unions, has taken the initiative in promoting the individual worker from the Labourers Union to other trade union membership for which he has shown capability and interest.

"Native Outreach believes that this kind of affirmative action with regard to initial entry and promotion on the job site deserves recognition.

"We believe that this model for action results in good employment for Native people in any local area and proves that it can be done and in a way that benefits the Native people who become a meaningful segment of the workforce both in numbers and quality."

### The local community

So far as the local community, as represented by Fort McMurray, is concerned, company policy is to participate with other contributors to the social picture. "We do not wish," to quote Terry Garvin, Community Relations Co-ordinator who, incidentally, is also responsible for the Native programs, "to erect any monuments to corporate paternalism." And this just about sums it all up.

The company rightly feels it has responsibility to ensure that the local community benefits from the new industry and that these benefits should be reflected in everyday life and social, recreational and cultural activity; but, as Garvin adds, "without sounding too patronizing, you might say that it is a matter of helping people to help themselves."

Fort McMurray is not a company town and the company feels that, despite the pressure that has often been brought to bear from some sections of the community that the company should sponsor certain organizations, sports teams or community ventures, anything it contributes to should be community initiated, community owned and community run.

Support, not sponsorship, then, is the guiding principle.

Within these guidelines the company has identified itself with a wide range of social, cultural and recreational activities in the Fort McMurray area. In money terms, this support over the past two years translates itself into a figure of well over $500,000.

Projects and activites supported by the company range from the Joint School Board who are receiving $68,000 spread over three years for instruments and music in order to conduct a music program in secondary schools, to such organizations as the Oilsands Ladies Curling Club who got $150. Contributions come from three company funds — capital projects, volunteer leadership training and a general fund — and practically every community leisure and cultural interest is covered in the register of recipients who have already benefitted. And it is not only local organizations and societies who have benefitted, for support has also been, and continues to be, given to community projects — for instance, ice rinks being constructed by the town's Parks and Gardens department and a study of the proposed MacDonald Island recreation complex.

"We wish to be a responsible corporate citizen," Terry Garvin concludes, "by relieving some of the pressures we have caused on the public facilities at Fort McMurray — and, as a spin-off, help provide amenities for our own employees."

*A general view of Fort McMurray*

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# Management–Labour relations

*"A remarkable record has been achieved in keeping the Syncrude project on schedule," says Neil Crawford, Minister of Labour, Government of Alberta*

According to Labour Minister Neil Crawford, there is an intangible ingredient in Alberta's formula for maintaining a stable labour climate. It is only a feeling and not the sort of thing you can nail down with unassailable proof — but he is convinced it is there nonetheless. It had to do with the fact that Albertans, on the whole, are people who still believe in order.

Says Crawford: "They tend to develop attitudes based on the assumption that they will get the work done rather than obstruct it."

When combined with more tangible factors, such as traditionally responsible labour leaders and "a fairly young emerging economy", this attitude has helped to put Alberta in a favorable position compared with other parts of the country when it comes to labour disruptions, he claims.

Despite past experience, however, Crawford is convinced legislation that cleared the way for the no-strike, no-lockout agreement between contractor and trade unions at the Syncrude site was a good move because of the enormous implications of a holdup in the most massive construction project ever undertaken in Alberta. "I think in a job of this size, a remarkable record has been achieved in keeping it on schedule. There has been virtually no interruption since work began and the quality and progress of the job undoubtedly reflect the wisdom of the arrangements that were made."

Would the same agreement apply in the case of further tar sands plants or other major resource developments? "Naturally we would like to see as smooth a relationship as possible with labour and we'll look for ways in which this situation can be repeated. We don't consider the way labour relations have been handled on the Syncrude job binding on the future, however. We would need to know what developments were in the offing and at that point assess the need for any type of framework similar to this. By that time we might have learned something that would suggest we do things differently in another project."

Since two-year contracts covering the bulk of construction workers in the province were concluded by The Alberta Construction Labour Relations Association in 1975, last year was a quiet one on the construction labour scene. A glance backward to the labour disruptions that accompanied 1975 negotiations could produce gloomy predictions for 1977 — but Crawford does not feel that problems are inevitable. "At contract time there is always some risk of a major or minor loss of workforce on some projects — but I don't foresee any unusual or extraordinary risk involved in this year's construction industry negotiations."

While some observers are predicting that the end of the construction phase at Syncrude will see hundreds of workers stranded without jobs, Crawford predicts the opposite effect. The existence of a large workforce on the Syncrude site, including trades mostly likely to be in demand for any large industrial project, could well act as a stimulus to new development, he believes.

If the minister tends to take a positive view of most facets of the Syncrude project that concern his department, his enthusiasm is most obvious when he discusses the native employment picture at the site.

"The project has given rise to the most successful native hiring program I'm aware of anywhere in Canada. It's an exceptional example of what can happen when everyone involved agrees to co-operate and make a few commonsense changes in the usual approach to hiring native people."

The provincial government, Canadian Bechtel, Native Outreach (a native liaison group), the unions and the native workers themselves all come in for praise from the minister for their efforts "to get large numbers of natives into well-paid jobs."

To begin with, he explains, government input is critical in the provision of training courses for native people at Fort McMurray's Keyano College. Unions and contractors do their bit by participating in training as instructors and then hiring students once they graduate.

The success of the program is due in large part to the fact there is no tokenism involved, Crawford believes. There is no question of native people going through the industrial workers' training course and then being told they will be called when work is available, he says. "This was the way it was once done with the result that students had a tendency to return to their previous environment. When the call finally came, many weren't interested in jobs."

Now, he points out, Bechtel policy is to hire immediately after graduation. "You get your diploma and you're on the job today — a policy that leads to a high degree of retention."

Initial acceptance of native workers as labourers is gradually leading to acceptance in trades such as welding — and to the increased wages that go along with such jobs. "The aim is to ensure that, at some point, virtually all trades will have a significant representation from native people."

While the labour minister does not suggest that the scheme is apt to solve all the current problems faced by Alberta's native population, he insists the essential point is that "there are large numbers of native people — currently about 700 and, at any given time, about 10 per cent of the total workforce on site — employed in well-paid jobs."

The whole program has proved so successful, he claims, that native hiring programs on future projects elsewhere in Canada are likely to be modelled on the Syncrude experience.

More inclined these days to talk about co-operation than confrontation, Crawford refers to a reorganization of government's approach to the total management-labour situation in Alberta that places more emphasis on labour relations.

Begun two years ago, the program is "now coming to fruition," he says, adding that one result is "structures that will cause labour and management to address problems less on an eyeball-to-eyeball basis."

"Any day of the year we can find a dispute that arises from the fact that people aren't talking and are therefore misinterpreting each other's motives."

Government hopes to help change this situation

through encouragement of labour-management workshops. In the bargaining process, government's role is to guide both sides to an accommodation — "which is in effect a compromise of the parties involved" — rather than to impose terms neither side wants to live with. He regards the key to this approach to be a good skilled group of mediators. Whenever it becomes apparent that "government is actually interfering very little — but our people are extremely busy," he is aware the mediation process is working.

Also supporting increased labour-management interaction throughout the year — and not just at the bargaining table — is recently enacted occupational health and safety legislation. In an attempt to place responsibility for safe working conditions squarely on both employer and employee, the legislation provides for formation of joint worksite health and safety committees.

"We are committed to having the first of these committees in operation by June," notes Crawford. In the meantime, the list of industries required to have the committees is being drawn up — a list which will almost certainly include the construction industry as an early entry.

What the new legislation means, he says, is "a careful and well-programmed increase in the involvement of government in occupational health and safety." Through the establishment of joint worksite committees it is hoped the whole question of safety will be removed from an adversary environment to become, not so much a matter for negotiation, as the basis for greater management-labour co-operation to achieve a worthwhile — and common — goal.


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# "A model for the future"

*"We believe we have set some firsts" says Bob Paul, president of Canadian Bechtel*

Innovative pre-assembly methods used in the building of the $2 billion Syncrude Canada plant on the Alberta oil sands may well prove a model for future giant energy-tapping construction projects in remote areas, according to Robert H. (Bob) Paul, president of Canadian Bechtel Limited.

In four years, and with a work force that has reached 8,700, Bechtel has lost only 140,000 man-hours — the equivalent of roughly two days' work at current employment levels. Paul says the record is "rather gratifying and reflects the co-operation and support of many individuals and organizations".

And Alberta native peoples' spokesmen have paid a warm tribute to Bechtel, saying the company has "set precedents" in hiring and giving opportunities to native people — "we're particularly proud of that," Paul adds.

Canadian Bechtel engineers talk of having established a pre-assembly system that could "revolutionize" construction techniques. Paul, a man not given to superlatives, says: "We share the credit with our client, but we believe we've set some firsts."

When Bechtel got the contract to build Syncrude, it was faced with the prospect of providing a huge oil extracting plant in a relatively remote area. As Paul puts it: "Our first consideration was the economics involved. We could build a camp capable of housing every worker at Mildred Lake, with all that involves in the provision of accommodation, recreation facilities and all the services that go with long-term occupancy, or we could reduce the size of the camp considerably if we could assemble as much of the plant as possible at Edmonton.

"Of course, taking the second route gave us other advantages on top of the savings in having a smaller camp on the site.

"We would be able to draw on the large pool of skilled workers at Edmonton and offer many jobs to workers with the assurance they would be able to be home every night, instead of having to spend weeks at a time in a camp. That's a big inducement to many workers.

"Then we were also able to reap some real benefits in productivity. Workers would be able to assemble much of the plant under shop conditions. That means working in comparative comfort — it's much more pleasant than having to assemble at a 200-foot height in a howling gale.

"For the company, it has meant that productivity has not been hampered by the vagaries of the weather. It also gave us some flexibility in scheduling some of our activities."

So Bechtel leased three sites in Edmonton — Paul said it would have preferred to carry out all the pre-assembly operations at a single site, but this proved impossible to attain — and the three Edmonton sites have provided jobs for more than 1,600 of the total 8,700 men and women building Syncrude.

Edmonton's Site 1, what Paul calls "the nerve centre and office warehouse complex" is close to Edmonton Municipal Airport, with 40,000 square feet of inside space and 2.5 acres outside. The centre is responsible for production planning, and material and cost control at all three Edmonton locations. It also houses finance, accounting, data processing and reprographics services — "another way we have avoided some of the costs and problems that would be associated with maintaining personnel in isolated areas," Paul adds.

Site 2 covers 70 acres, mostly outdoors, on the outskirts of Edmonton, and comprises assembly shops, storage and laydown areas for pipe, other equipment and modules.

Bechtel's Edmonton Site 3 is on eight acres with a big warehouse and yard, concentrating mainly on fabrication and pre-assembly of civil, electrical and mechanical components.

### "Innovative approach"

One "innovative approach" used, Paul says, was in pre-assembling electrical conduit configurations. Originally, these were to be laid in trenches on the site, and concrete poured around them. Bechtel did a study which showed that prefabrication of complete electrical duct banks embedded in concrete was possible. Paul says he man-hour saving using this process is huge.

"As the work progressed, we were able to bring in other innovations. One was the development of concrete foundations. First, form panels were built and sent to the site. Then, forms were put together and the rebar installed before shipment. Eventually, Edmonton began shipping precast foundations which were merely lifted off at the site and set into position."

Paul says the system of assembling at Edmonton "has proven more efficient than trying to put everything together at the site. We have controlled working conditions that are in general a big improvement to work under, compared to field conditions. Productivity and quality control have proved easier to maintain. The system also has reduced the effect of material shortages which, when they happen at the job site, cause unavoidable delays."

The Canadian Bechtel president concedes that pre-assembly is not completely new to the construction industry, but points out the Edmonton operation is the biggest so far of its kind. "We are proud of its performance to date. What we did basically, is bring the work to the people instead of taking the people to the work".

Paul said he is "enthusiastic about the possibilities of future applications of the pre-assembly technique, particularly in an era when we presumably will have more super-projects in remote areas where labour is in short supply, facilities expensive and the cost of maintaining a very large work force close to prohibitive."

Representatives of refining, pipeline and utility companies have visited Bechtel's plants to study processes being used.

Despite the complexity of the construction program, Paul says that the building of the Syncrude plant is "overall, essentially on schedule, so far as current forecasts are concerned, and we hope to hold to that".

*(continued on Page 30a)*

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## Bob Paul — continued

Keeping to schedule is vital, he says, because "if this plant was delayed in any way, it would affect our client's economics for the project."

Contracts with "hundreds of suppliers of materials and equipment, many engineering companies and a number of construction suppliers" all have had to be co-ordinated to meet schedules and budgets.

"There is no secret to doing this," Paul says. "We have all sorts of systems and procedures that we have developed over the years for this kind of work — that's our investment, our know-how."

Ingredients include weekly reviews at the site to ensure facets of buildings are on schedule and budget, reviews on about a monthly basis in Edmonton, and regular visits to sites by senior management and specialists. "We are constantly on top of how the pre-assembly work orders are progressing and how the money is being spent."

As an example of co-ordination required, Paul cites the case of the provision of huge cylindrical vessels, several weighing more than 385 tons.

Some were manufactured in Italy, brought by ship to Canada and transported to the job site on special rail cars. They had to be moved over the Northern Alberta railroad bed when the ground was frozen, because of the danger of ground shifting, and a new bridge had to be built at Fort McMurray, the main oil sands' community, to get them to the plant site.

### Excellent labour relations

Paul attributes the almost total absence of disruptive labour stoppages on the project to "our own excellent labour relations staff — they're dedicated and far-sighted — and the extremely good co-operation we have had from the unions".

Canadian Bechtel's president, who knows something of both sides of the fence — he apprenticed on the Canadian National Railway and is an honorary member of the Boilermakers' Union — says his company "has always tried to maintain a continuing good relationship with unions, both at times when we are a big employer and at times when our work force is not so big, and this helps when you come to negotiating with them."

Paul adds that Bechtel is helped by its "very high quality labour relations force" under W.J. Gibson, vice-president in charge of labour relations, a trustee of several union funds and "the dean of labour relations experts in Canada in the construction industry, a man who has the confidence of workers."

Paul says one advantage his labour relations team has is that it is expert in Canadian industrial relations. "Canadian labour relations laws differ from those in other countries — in fact, they differ from province to province. Our people are well versed in them. We also know where the pitfalls are and can take some measures to avoid them."

On the Syncrude project, for instance, Bechtel's labour relations staff hold meetings weekly with union shop stewards. James Cunningham, labour relations manager for the company on the project, says routine problems at the site — such as complaints about food or accommodation — are brought up at the meetings and attempts made to remedy them wherever practicable.

Meetings are also held monthly on the site between the business managers of the unions — as many as 17 unions are involved in the work — and Bechtel labour relations staff and management.

"This is where bigger complaints are brought up — for example, if a union thinks we are not moving fast enough on something it wants for its members or some of its members," Cunningham said.

"The whole process is aimed at keeping each oth informed — that's something we regard as essential to the maintenance of good relations and productivity."

Potential jurisdictional disputes — virtually the only kind of problem that has caused any type of work stoppage at Syncrude — are discussed separately with the unions involved.

Cunningham said: "There is a recognized procedure. We refer first to agreements and decisions which have been recorded and are recognized between the two crafts. If there are no such past agreements we ask the unions to supply evidence to substantiate their claims — letters from other employers, and so on.

"We point out to the unions what past practices have been, then we make a judgment as to whom the work belongs.

"If either union is offended by the decision, it is resolved by following procedures as set out in the pertinent local agreements. If you try to short-circuit this process, you're going to get into trouble."

Cunningham says that at Syncrude "all the unions also deserve a bouquet for the way they have co-operated with us in the hiring of local people, be they union or non-union, provided they have the necessary skills."

The unions particularly have helped where Bechtel wished to hire local Indians and Metis to work on the project. The Alberta Native Communications Society said recently that Canadian Bechtel "leads the way in non-discrimination" in hiring. Last September the company became the first to receive the Native Outreach Employment Award "in recognition of significant achievement in the hiring, training and promotion of native peoples in Alberta."

Native people are among 565 who have graduated as welders from a school Bechtel set up at its Edmonton pre-assembly base.


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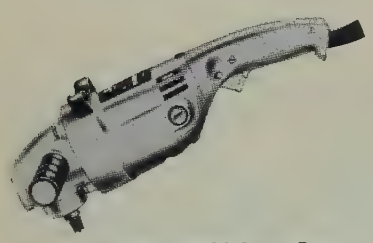

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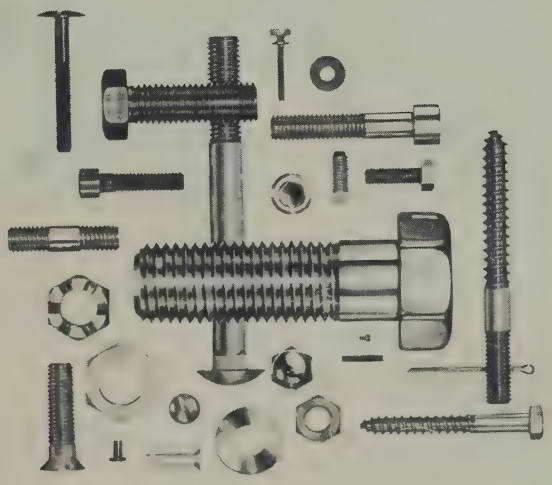

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Canada-Cities Services Limited 22 per cent.
Gulf Oil Canada Limited 16.75 per cent.
Federal Government of Canada 15 per cent.
Provincial Government of Alberta 10 per cent.
Provincial Government of Ontario 5 per cent.

The agreement that brought the federal and the two provincial governments into the venture was reached in 1975 and followed the withdrawal in 1974 of Altantic Richfield Canada Limited which left the full financial weight of the massive project on the shoulders of the other three petroleum companies. It came about as a result of a declaration by these three companies that unless a new investor was found by January 1 1975 the project would have to be postponed or abandoned altogether.

In response, the three governments indicated their intentions of investing a total of $600 million in the Syncrude project — $300 million from the federal goverment for a 15 per cent interest, $200 million from Alberta for 10 per cent and $100 million from Ontario for five per cent.

The three remaining oil companies agreed to increase their participation to make up the remaining funding. Imperial Oil invested $625 million for an interest of 31¼ per cent; Cities-Service agreed to spend $440 million for a 22 per cent share and Gulf Oil Canada bought 16¾ per cent for $335 million.

The original agreement with Alberta gives that province an option, through the Alberta Energy Company, to acquire a further 20 per cent of the equity after start-up. Loans from the Alberta government to Canada-Cities Service and Gulf Oil Canada of $100 million each are in the form of debentures convertible to equity. Should these options be exercised, the province of Alberta would own 38 per cent of the project. The other two governments would have a total of 16 per cent, giving governments a maximum possible share and majority ownership of 54 per cent.

The major share of revenue to governments will be to Alberta which under the original agreement, receives 50 per cent of deemed profits in lieu of conventional royalties which normally accrue to the province. It also will receive a share of profits as one of the six equity investors in the project. The oil produced will be divided among the oil companies and the three governments according to their investments.

In addition to their financial interests in the project, the various governments are now included in the policy-making and control organizations within the company. The steering committee and the management committee, both policy-making bodies, are composed of one member from each of the governments and one from each industrial participant. The Board of Directors of Syncrude Canada Ltd. has representatives from the provinces of Alberta and Ontario and from the three oil companies, together with a director from the federal government

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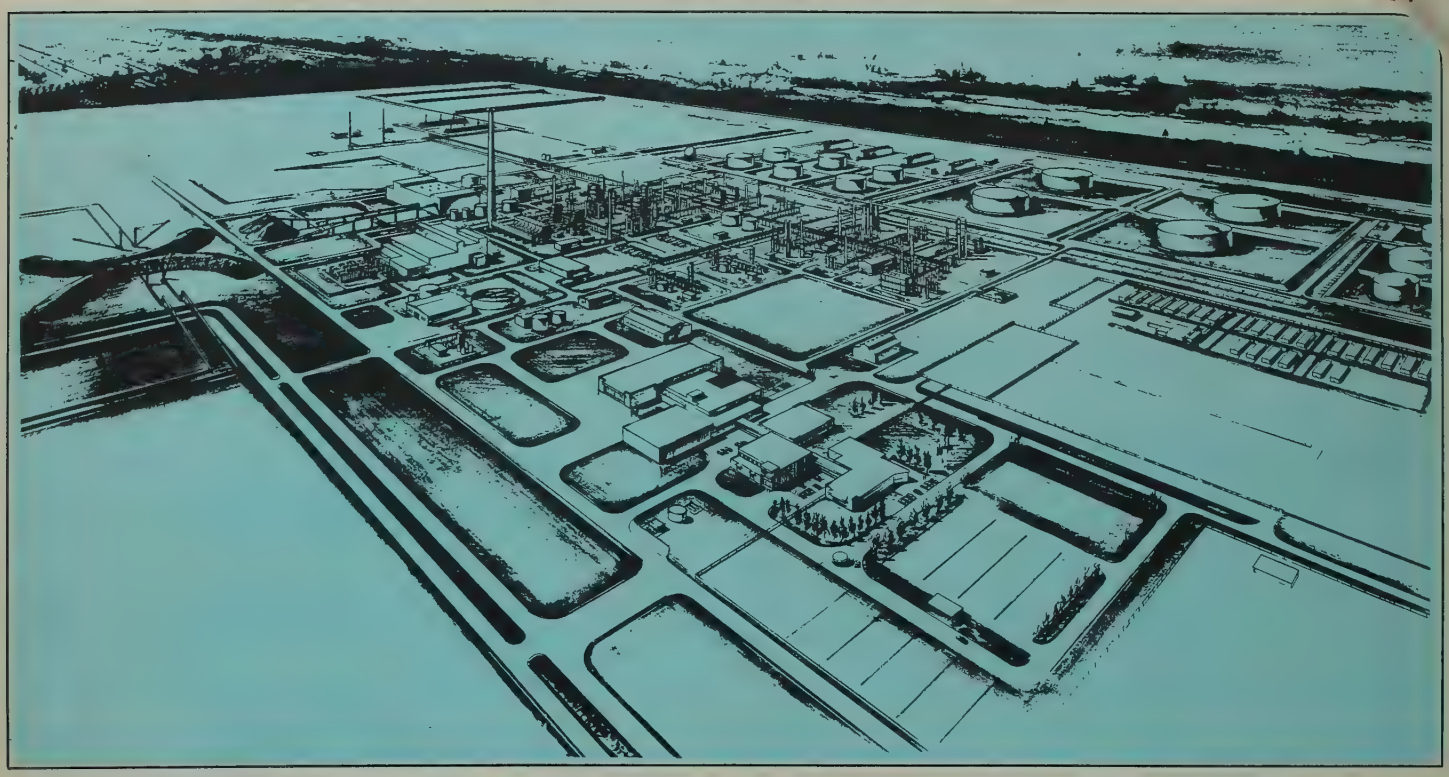


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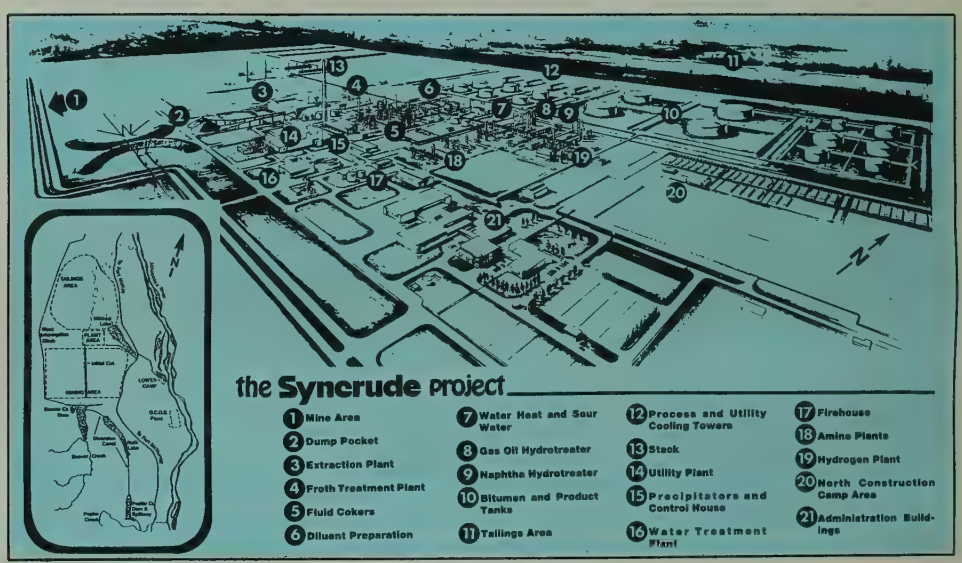


## the Syncrude Project

1. Mine Area
2. Dump Pocket
3. Extraction Plant
4. Froth Treatment Plant
5. Fluid Cokers
6. Diluent Preparation
7. Water Heat and Sour Water
8. Gas Oil Hydrotreater
9. Naphtha Hydrotreater
10. Bitumen and Product Tanks
11. Tailings Area
12. Process and Utility Cooling Towers
13. Stack
14. Utility Plant
15. Precipitators and Control House
16. Water Treatment Plant
17. Firehouse
18. Amine Plants
19. Hydrogen Plant
20. North Construction Camp Area
21. Administration Buildings

## KEY

*2. The extraction feed system receives the mined tar sand and provides an even flow of presorted sand to the extraction facilities.*

*3. The extraction plant separates the bitumen from the tar sands. This is accomplished through the mixing of hot water and chemicals with the tar sand.*

*4. The froth treatment system removes water and solids from the bitumen extracted from the tar sands. This is achieved through the mixing of naphtha with the bitumen, followed by two stages of centrifuging.*

*5. Primary conversion process for the separation and conversion of bitumen into gas, naphtha, gas oil and coke fractions, and the recovery of gas and liquid fractions for subsequent processing.*

*6. The diluent preparation unit produces naphtha used in the dewatering and demineralizing of bitumen in the froth treatment process.*

*7. The waste water treating plant handles sour process water containing hydrogen sulfide and ammonia, removing each of these selectively. The recovered hydrogen sulfide stream is fed to the sulphur plant. The ammonia will be either incinerated or recovered as a liquid ammonia by-product.*

*8. The gas oil hydrotreating unit processes the gas oil recovered from the primary conversion process. This process is accomplished catalytically in the presence of hydrogen. Sulphur and nitrogen removal, olefin saturation and some conversion of higher to lower boiling range components are effected.*

*9. The naphtha hydrotreating unit processes the naphtha used in the primary conversion process and gas oil hydrotreating process utilizing a catalytic operation in the presence of hydrogen. This process removes sulphur and nitrogen from the naphtha and effects saturation of its olefinic constituents.*

*10. Tankage consists of storage facilities for hydrocarbon products, both treated and untreated, as well as chemicals.*

*11. The tailings disposal system transports water and sand tailings from the extraction and froth treatment plants to tailings disposal ponds during the initial three to five years of operations, and to the mined-out area when the mine is sufficiently advanced to allow disposal of tailings without interference with mining.*

*14. This plant generates power for the entire operation on the site.*

*18. The amine unit includes the absorption and regeneration equipment and facilities required to remove and recover hydrogen sulfide from the gases produced in the upgrading processes. The hydrogen sulfide recovered is used as a feedstock for the sulphur recovery unit.*

*19. The hydrogen plant manufactures hydrogen from natural gas. This hydrogen is in turn used in the secondary upgrading units (hydrotreaters).*

# Project now 72% complete

## Major impact on Canadian and provincial economies

*Two fluid coking units*

Construction of the $2.15 billion Syncrude project is now (May 1977) 72 per cent complete, within budget and on schedule for its mid-1978 start-up.

The workforce at the site peaked this spring at 7,500 men and women making it the second largest construction project in Canada — next only to the James Bay Hydroelectric job. The workforce this summer is again expected to reach 7,200, then start tapering off as completion nears.

Meanwhile the company has launched a major recruitment drive across Canada to fill the 2,500 permanent jobs being created at its plant.

Syncrude's present workforce both in Edmonton and Fort McMurray numbers about 1,500.

In addition to the on-site construction workforce, Canadian Bechtel, the managing contractor for the project, has over 800 employees and sub-contractors working at four pre-assembly sites in Edmonton, where large amounts of piping and pre-cast concrete work are carried out and from where the equipment is shipped north by truck over the 302 miles to the plant site. The four sites encompass 81.5 acres, and 252,000 square feet of indoor space are being utilized as well. The pre-assembly operation in Edmonton is the largest of its kind in the world and by the beginning of spring the Edmonton workforce had expended about three million man-hours. By the time the project is finished, accumulated pre-assembly work is expected to reach four million man-hours.

At the Syncrude site itself, some 12,000 acres have been cleared, 42 million cubic yards of earth removed, plus 5 million cubic yards of muskeg which is being stored in piles around the site for use in reclaiming land disturbed by construction.

As described elsewhere in this Supplement, the course of Beaver Creek, which ran through the centre of the 7,000-acre mine site, was re-routed and two earthen dams and a large concrete spillway built to divert the creek away from the mine site and back into the Athabasca River, via Poplar Creek. The entire diversion project cost $27 million and has two main objectives — the first to drain the mine site so that mining can be carried out safely and, secondly, to accomplish the diversion without causing erosion. Areas around the spillway disturbed by construction have already been revegetated in the first of what will become a 30-year land reclamation program spearheaded by Syncrude environmental experts.

In addition to plant construction, the 260-megawatt utility plant, which will provide power for the project, is complete, while the water treatment plant, the largest of its type in the world, will also be ready this year. It will process 6,000 gallons per minute of demineralized water, and 7,000 gallons per minute of cooling water.

Assembly of the first two of four 80-cubic-yard bucket, 6,500-ton draglines which will be used to mine the tar sand will also be completed this year. Each dragline takes about 15 months to assemble and costs about $30 million. Two of four 426-foot-long bucketwheel reclaimers are being assembled and the first will be completed by the summer.

Before it is finished, the project will require 325,000 cubic yards of concrete, 27,920 tons of structural steel, 2.8 million linear feet of piping and 9.6 million linear feet of wire and cable.

Of the almost $1.5 billion committed to date on the project, 58 per cent is being spent in Alberta, 16 per cent in Ontario, five per cent in other parts of Canada and 21 per cent outside Canada.

Recent labour force statistics show that 74 per cent of the Syncrude workforce and 90 per cent of Canadian Bechtel workers and sub-contractors are Albertans, while 23 per cent of Syncrude workers and three per cent of Bechtel workers and sub-contractors are from other parts of Canada. Non-Canadians with Syncrude total three per cent; those with Bechtel and its sub-contractors just seven per cent.

Taking into account the workforce at the project site, at the three Edmonton pre-assembly yards and at the headquarters in Edmonton of both Syncrude and Canadian Bechtel, about 10,000 people are directly employed on the Syncrude project. This does not include hundreds of workers and engineers in shops and offices throughout Alberta, and many hundreds more employed with companies across Canada who have received various contracts from Syncrude.

In Edmonton alone, more than $200 million has been directly pumped into the economy by construction of the project, and in keeping with Syncrude's commitment to maximize Alberta and Canadian content in the project, a total of 79 per cent of the entire costs of the project has been spent in Canada, and 74 per cent of the engineering work has been done by Canadian engineers. Between 500 and 600 Alberta firms are supplying goods and services to Syncrude and between $2 million and $3 million a day is flowing through the Syncrude bank account.

Recent estimates place Syncrude's overall economic impact on Edmonton at $800 million, growing to between $3 billion and $4 billion over the next few years.


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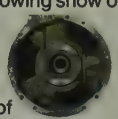

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# Concrete piling in the tar sands

## Conventional methods abandoned

A great deal has been learned about concrete piling in the tar sand areas, for the geological formations in the Fort McMurray region were not laid down with pile driving requirements in mind!

In the pile pouring operations at the Syncrude site problems caused by extremely sandy soil and high underground water levels had to be overcome and, when conventional pile driving methods proved unsuccessful, Western Caisson Ltd., who poured an estimated 100,000 feet of concrete piles at the project adopted the use of vibro pile drivers/excavators with steel caissons.

"We tried to drill holes in the normal way but the soil is so sandy the walls caved in after only a foot of drilling," says Jim Ruzycki, superintendent of Operations for Western Caissons. "Also we frequently ran into water pools that would completely fill up a hole not protected by a caisson."

Western Caissons drove steel caissons into the ground as the first step in the pile pouring operation. The caissons shielded freshly poured cement from water and they provided wall support for the piles.

In winter, the ground was hard enough to support drilling for several feet before insertion of the caisson, but in summer the caisson was driven directly from the surface.

Vibro driver/extractors were used to drive the 24 to 48-inch sized diameter 35 to 40 foot carbon steel caissons until they reached the tar sands.

Most of the driving was done with two electric powered L.B. Foster model 2-75A Vibros. The Foster units are powered by two 75 hp. motors that rotate eccentric weights at high speed. Two 85 hp., hydraulic motors power the ICE Vibro unit that was also used.

Although both kinds of machines performed well, the Foster Vibro was more suitable for cold weather operation, as the electric cords provided a more reliable power source than hydraulic hoses, which often froze.

Vibro driver/extractors are especially suited for this kind of job. The vibratory action breaks the grip of soil on the sides of the caissons during driving and frees the caissons from cement during their extraction.

The vibro driver /extractors operate almost twice as fast as impact driven pile drivers in the sandy soil conditions. As the caisson moves into the ground, sand particles are dislodged to the side. The particles are not compacted under the caisson as they would be with an impact pile driver with the result that there is no effective refusal distance.

After driving more than 4500 piles, Ruzycki says the vibro driver/extractors, which are rated at 150 hp. with a maximum extraction line pull of 40 tons, have never encountered a caisson too difficult to extract.

"We once had a caisson

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*A Horton pressure sphere, with a fluid coker in the background.*

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stuck so hard an 80 ton capacity crane couldn't move it," Ruzycki recalls. "But when we hooked up the Foster 2-75A, it moved without any problem."

Although the tar sands are adequately constituted to support tiles, the sands often are covered with a 30-foot mixture of gravel, sand, till and clay. On top of that lies muskeg that can dip as much as 30 feet below mean ground level.

Preparatory to the pouring of piles, the site was rough graded into a 10-foot layer of surface sandfill. This left two layers for the caisson to penetrate before it reached the tar sand, the sandfill and up to 30 feet of natural material.

A vibro driver/extractor drove the caisson to the level of the tar sands and then earth inside the caisson was drilled out with a Hugh Williams model LDH 100 drilling rig. At the Syncrude site the company usually worked two drilling rigs with each vibro driver/extractor.

A belling tool hollowed out a cone-shaped area four to six feet deep and up to 108 inches wide in the tar sand beneath the end of the caisson. This increased the base area of the pile that will be supporting the weight of the pile and the building above it.

"We ended up checking about three times as many holes on this job because of the poor soil conditions," says Ruzycki.

Once the hole had been approved, ¾-inch steel rebarr was lowered into the caisson and the concrete poured. Approximately six cubic yards of cement were required for an average 30-inch diameter, 30-foot caisson.

One of the vibro driver/extractors then pulled the caisson free. Operating at the very quiet 82 decibles, the Foster vibro machine could drive and extract the caissons up to five times faster than conventional equipment.

Normally piles ran about 30 feet long at the Syncrude project. However, on the 72 kv line carrying power from the 260 megawatt generating station to a water pumping station by the Athabasca River, some piles were poured 80 feet in the ground.

The same caisson method was used on the deep holes without any difficulty by combining two caissons, one on top of the other.

In some areas where the water content is high the crew pumped bentonite clay into the hole to seal off the water until the tar sand could be drilled out and the cement poured.

Apart from soil conditions and water content, other factors have contributed to the difficulty of pile laying at the Syncrude site.

The abrasiveness of the tar sands added considerably to equipment wear. Heavier liners had to be rolled and fastened to the bottom of caissons and they were replaced after every 500 holes.

Caissons were sometimes stopped by layers of sandstone 3 inches to 18 inches thick. The company first tried coring these out with a core-barrel equipped with chronicle teeth, but this proved to be too expensive a method and the crew reverted to a six-ton chopping bit with a 10-foot drop.

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# Transportation vital to infrastructure

*The challenges of the tar sands projects are commented upon by Bob Cronkhite*

*Bob Cronkhite, Deputy Minister of Transportation, Construction, Government of Alberta*

One of the most challenging jobs ever undertaken by Alberta Transportation has been the upgrading of a 17-mile stretch of road from Fort McMurray to a point between the Syncrude and Great Canadian Oil Sands plants.

Traffic rather than terrain has been the culprit in this case, says Bob Cronkhite, deputy minister, construction.

Massive truck hauls, traffic related to escalating construction activity at the Syncrude site, and dozens of commuters on shift work at the GCOS plant have somehow had to be accommodated in and around and through the upgrading operation. So far, it's an exercise that has occasionally frayed tempers. But, for the most part, it has been handled with reasonably good understanding by all concerned, says Cronkhite. He adds that union representatives have co-operated with department officials in an effort to minimize problems for both construction crews and commuters.

"There was no alternative route from the town to the plant sites — so there was no choice but to work in the midst of heavy traffic." Both the volume of traffic and the fact it was necessary to provide extra-strength pavement to support exceptionally heavy loads have contributed to a project that is taking longer than normal to complete, he says.

As in the case of all roadwork in the Fort McMurray area, there was no question of delaying the project. "It was essential that we continue to upgrade the road and at the same time accommodate traffic. Any slowdown in delivery of materials and equipment that could leave up to 7,000 workers standing idle at the Syncrude site, would have had horrendous implications."

Those who have been contending for months with the confusion of signs, flagmen, delays and dust (the road is being built of dirt and the light oil treatments which have been applied are not effective for long), will be happy to know the end is in sight. With regrading now complete and the last contract for heavy duty base pavement out this year, the department is hoping for a completion date of year-end 1977 — "provided there isn't too much rain."

Work in the Fort McMurray area has topped the department's priority list for the past four years, during which an average of $10 million per year has been channelled into area projects, including upgrading of Highway 63 and roads to the airport, tar sands plants and Northern Alberta Railways marshalling yards at Lynton, together with the construction of heavy duty bridges and upgrading of the road through the townsite. Cronkhite estimates that by the end of this year the department will have spent about $52 million in the area. "This year's push will get us clear of the very heavy expenditures we've had in the region since 1973."

Within the townsite, the project considered most urgent is the widening and stabilizing of the hill portion of Highway 63, leading into the town from the south. According to Cronkhite, the department feels it is crucial to complete this work first because of the danger of tie-ups and for safety reasons. Tremendous pressure has been brought to bear on this section of road by increasingly heavy traffic from the upper townsite and airport.

Before twinning of the highway can begin, stability of the road has had to be improved by moving tons of material from upper to lower levels of the slope. In addition, a diversion of Saline Creek at the base of the hill was required. The creek was undermining the area and accelerating the sliding action.

Work on Saline Creek involved an operation which Cronkhite believes is a first of its kind anywhere in the world — creation of a full-scale tunnel in tar sand. A hole, 16 inches in diameter, was machine-bored through the sands. This is to be lined with steel culvert to handle the creek diversion. "This summer we'll fill in the old channel to support embankments for a wider highway above, with four traffic lanes and a clearing lane."

Work in the townsite is being carried out in phases with the first project covering Highway 63 from the main access into the residential areas at the top of the hill, to the far side of the Hangingstone River at the bottom. Extensive landscaping is planned for areas adjacent to the road and earth berms are to be constructed in several spots.

A further project will be required to complete twinning of the road to the bridge complex (already twinned). Subsequent stages will see twinning expanded north to accommodate heavier flows of residential traffic into areas north of the Athabasca.

Because of stability problems, particularly on the hillside, costs are relatively high, Cronkhite notes. The current project to widen and upgrade approximately two miles of highway (including base paveing) will cost an estimated $3.1 million.

Also planned for the area is a second approach across the Hangingstone River, designed to accommodate massive loads moving to the plant site from the highway and from NAR marshalling yards at Lynton. Work on this project is scheduled for 1978-79.

If the department has gained any "major hindsight" from the experience at Fort McMurray since the Syncrude project first received the go-ahead, it is the realization that the transportation requirement in any major resource development is not simply a frill, says Cronkhite.

"Transportation has to be considered as part of the initial proposal for development. We're very much aware that the whole question of road, air and rail transport has to be considered right from the start — as vital elements in the total infrastructure of the area."


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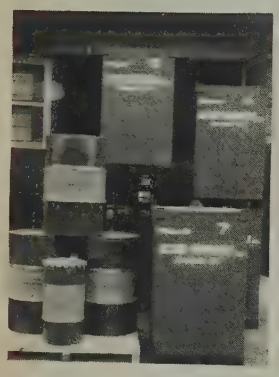

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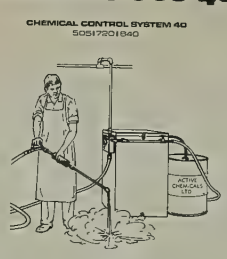


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# Realistic approach to housing

*"I am very well satisfied with the performance at Fort McMurray," says Bill Yurko*

Housing and Public Works Minister Bill Yurko is convinced that government control of land in Alberta's boom towns is the only way to avoid rampant land speculation and to keep housing prices — if not exactly low — at least within some sort of reason.

"If we had to do it again, we would likely take much the same approach as we have in Fort McMurray — controlling the price of land to keep it from skyrocketing and then using the private sector exclusively for engineering, planning and construction."

The department does not intend to develop that capacity itself, he stresses, adding that the Alberta Housing Corporation has a staff of roughly 20 in Fort McMurray.

If the thousands who have poured into the tar sands community in the past couple of years have complained that the housing market inevitably offers "too little for too much", they are probably justified in their feelings, Yurko admits. But he also insists that whatever problems the housing supply-demand situation in the town has produced, they would almost certainly have been multiplied many times over if the government had not kept a firm hand on residential development. Since 1973, AHC has become virtually the sole agent for residential land in the town.

"I'm very well satisfied with performance to date. I think miracles have been accomplished in Fort McMurray in the short time government has been working in the area with the private sector."

The high cost of construction in Fort McMurray in the past few years has resulted not only from the boom town aspect of the community, but also from the extremely high level of economic activity in the province generally, he says.

He anticipates lower tenders from the private sector in future as a result of a gradual slackening off of activity in the housing industry in Alberta in recent months.

Although construction and servicing costs both have been above average in the town, this has been offset in part by the fact that land costs virtually nil. "Land in Beacon Hill, Area 1 and Area 5 was provided for $160 an acre."

He notes that AHC has directly invested well over $40 million in developing residential areas in Fort McMurray, including 195 acres in Beacon Hill (Area 2) completed in 1975; 110 acres in phase one of the Gregoire Mobile Home Park, completed in 1974; and part of Thickwood Heights — the largest subdivision tackled to date with 1,101 acres capable of accommodating about 17,000 people when complete.

When financing for activities of Northward Development Ltd., the housing arm of Syncrude which acts as an agent of AHC, is taken into consideration, investment by the end of this year will include roughly another $70 million. "AHC finances Northward totally in terms of their development costs," he explained.

Further government investment in the area is channelled through the Alberta Home Mortgage Corporation program which provides for $40,000-maximum first mortgages on homes currently being developed by Northward. The remainder of the purchase price is provided by way of a second mortgage from the treasury at 4¼ per cent above AHMC general provincial lending rate. At the current 10½ per cent, the second mortgage rate becomes 14¾ per cent.

### AHC's largest single project

Noting that development of housing in Fort McMurray constitutes the largest single project ever undertaken by AHC, Yurko adds that total government investment in the area at any given time is difficult to pinpoint because there is always money "in transition" in the form of loan guarantees, direct payments through first mortgages and direct payments through the second mortgage concept.

While special AHC assistance has been necessary to cope with the massive demands placed on Fort McMurray, many of the corporation's province-wide programs are also in effect there. These include the Core Housing Incentive Program (CHIP) under which financing of $20 million was recently approved for Northward to build a downtown apartment complex — "but at the general provincial rate of 10 per cent — not at a subsidized rate."

AHC policy is to sell rather than lease residential land, Yurko says. "The corporation acts as landlord in Gregoire Mobile Home Park, but generally it would sell all residential property to the homeowner. Apartment sites, of course, have to sell to whatever company comes in to build on them."

Although the Co-operative Housing Action Program (CHAP), now sponsored and administered through Alberta Housing and Public Works, is becoming increasingly prominent in other areas of the province (500 detached units are expected to be built under the scheme in 1977, and another 1,000 in 1978), it has not been introduced to Fort McMurray because of the fact it is a high-cost area.

In cities such as Edmonton and Red Deer, however, the program is popular because it allows a group of people to buy together while acting as individual contractors and building up "sweat equity" to reduce cash expenditures and mortgages required. There is also a saving in land prices for co-op participants through a special arrangement with municipalities.

While the minister admits AHC "continues to examine Fort McMurray in relation to this program", guidelines allowing for 95 per cent financing to a $40,000 maximum, could make the scheme impractical for an area where average house prices are about $30,000 above that.

### More mobiles for Fort McMurray

New developments in mobile home parks are also being considered for Fort McMurray. "Phase two of Gregoire Mobile Home Park will bring another 500 units on stream and we're looking at future expansion there, if and when it's required."

In recent months the housing minister has made no secret of his attitude toward the performance of Alberta housebuilders and developers. "I said the industry generally was making immoral profits — and, as a result, they are now beginning to suffer. High priced homes just aren't selling."

He contends his point is supported by recent AHC

*(continued on Page 39a)*

*Bill Yurko, Minister of Housing and Public Works Government of Alberta*


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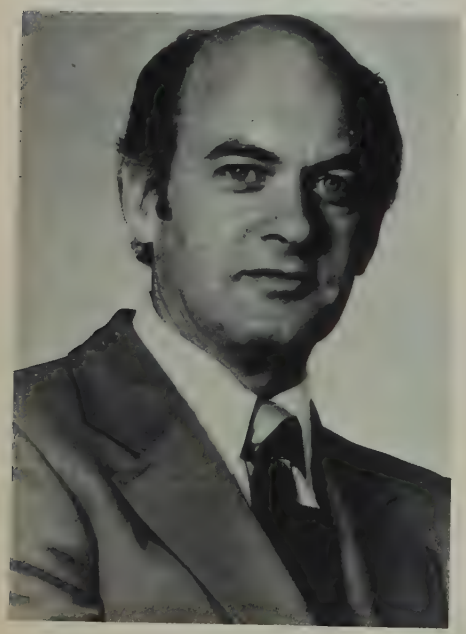
# Ontario willing to back energy projects

*But price of oil must be right for Canada says James Taylor Minister of Energy, Government of Ontario.*



Ontario is willing to consider investing in building energy-producing projects anywhere in Canada, the province's Minister of Energy, James Taylor says.

Ontario put up $100 million to help keep Syncrude on schedule when there were dangers it would be delayed because of Atlantic Richfield's withdrawal in 1975. (The federal government invested $300 million and the province of Alberta $200 million).

Taylor says Ontario is "extremely satisfied with our investment so far — the construction work is on schedule and we have had no indications our cost will escalate over what we originally promised."

His one major reservation is concerned with the cost at which the Syncrude oil is expected to be sold.

Taylor explains that Ontario's investment in Syncrude — it came as a surprise to many to see one province investing in a building project in another province — was simply because "We are the most energy-consumptive province in Canada; we have the biggest population and by far the biggest industrial capacity.

"Almost 40 per cent of our energy comes from oil. Ontario is now using about 200 million barrels of crude oil a year, which represents nearly a third of the oil being produced in Canada.

"Most of our oil comes from Western Canada; we get a small proportion, in eastern Ontario, from abroad.

"We are faced with the fact that conventional supplies of oil from the west are starting to run out, and foreign producers keep raising their prices.

"It was evident that, as domestic production of oil declines and the west's own consumption of oil rises, Ontario would be forced into world markets for more of our future crude oil.

"Apart from being at the mercy of artifical prices decided on by foreign oil producers, we also would have no assurance of supplies from those sources.

"Obviously, it was a prudent move for Ontario to invest in developing new resources in Canada."

Taylor says that Ontario feels estimates of the amount of oil and other energy resources in Canada have "lacked credibility. We've had a succession of forecasts and they have differed substantially. Recently, they have tended to be much less optimistic than they were at times in the past."

The Arctic and other frontier areas "offer potential for oil supplies, but we felt the best prospect for an early recovery of oil lay in the oil sands and there already was one plant in place in the oil sands which showed it could be done."

Ontario had an extra incentive to invest $100 million in Syncrude — the business it could generate in Ontario factories. "We were mindful of the fact that a lot of materials and equipment and components would come from Ontario. We estimated that abour 29 per cent of such contracts would be placed in Ontario, and that assessment has proved to be about right."

Taylor added that Ontario gets for its money "a five per cent interest in Syncrude and its profits and in the leases it has on other lands that can be worked for oil.

"We also have a five per cent interest in the technology developed by Syncrude, so that if Syncrude wanted to sell that technology to others wishing to develop the sands, we would get profits or royalties from that too.

"Above all, perhaps, we had the basic satisfaction in knowing our money would be developing Canadian resources, as distinct from those of other countries when we buy from abroad.

"It was made clear to us by other participants that Ontario's contribution was essential to keeping the project alive — we can take satisfaction from that."

Ontario has two members of a 12-member management committee who monitor the Syncrude project and its progress and meet monthly in Syncrude's Edmonton offices.

The province is also represented on each of a half-dozen sub-committees, including legal and accounting groups. "They have been able, from our viewpoint, to ensure the project is going according to both time and cost schedule," Taylor says. Representatives of the Ontario Energy Corporation, a provincial government agency, also visit the Syncrude site regularly.

### Price of the oil

One thing that concerns the Ontario minister is that the federal government has guaranteed that the project will be able to charge the world price for oil, which is constantly increasing.

Taylor feels Syncrude may well be able to produce oil at a price — even after royalties, taxes and "a small profit" are taken into consideration — lower than what the world price of oil will be when Syncrude comes into operation.

"Tying it to a world price would be wrong. If we can produce any oil in Canada cheaper than we can buy from abroad, surely the benefit should be passed on to Canadian consumers."

Taylor suggests the oil produced by Syncrude should be fed into the Canadian system at a price reflecting a small profit. Canadians would then pay a price based on the average cost of the imported and domestic oils, except for added transportation costs. He adds "Surely we don't have to pay the prices that a group of monopolists in other countries decide are suitable to meet their own selfish ends.

"We would like Syncrude oil to be sold at a below world price if it can be produced for less, and we will push to achieve this."

Ontario is ready to look at investing in projects that will provide energy anywhere in Canada, Taylor says.

Six months after agreeing to put money into Syncrude, Ontario invested $10 million in a study into the feasibility of building a natural gas pipeline from the Eastern Arctic Islands — mainly Melville Island — to southern Canadian markets.

Others in the Polar Gas Project include two oil and mining companies, two utility companies and a pipeline company.

"Our principal guides in deciding whether we would invest are: is the natural resource Canadian? Is there a prospect of an adequate yield from the resource? Would any project help Canada become self-reliant? And are there opportunities for proper environmental safeguards?

"We would also be willing to consider investing in new pipeline systems and other facilities that may be needed to bring supplies to market."

The Ontario minister says that because of the huge costs involved — "it's no longer rare to talk of costs in billions of dollars in energy-producing schemes — it has become almost inevitable that governments will be involved more and more in projects like Syncrude.

"Individual corporations no longer can provide enough money for these kinds of tasks — frequently the sums are too high even for groups of companies in a consortium.

"So we expect government more and more to become involved, and to act as the honest broker, to bring private enterprise together and to help in providing the necessary backing."

But Taylor insists: "Despite the growing role of governments, the major role in building huge energy-providing projects will still be that of private enterprise.

"Private enterprise has the expertise and the technology and it will continue to provide the capital to develop where possible. As far as we in Ontario are concerned, Canada still has a market-place economy."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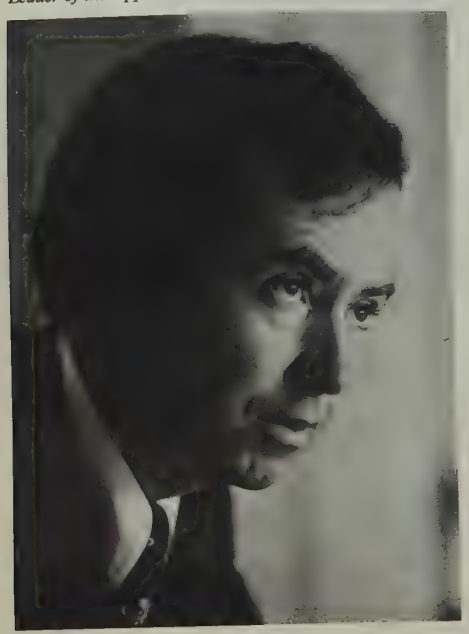
# Continuing sense of insecurity

*Written for Construction Alberta News by Joe Clark, Leader of the Opposition, Federal Government of Canada.*



Possibly the most persistent effect of the OPEC oil crisis of 1973 is a continuing sense of insecurity. The supply of oil, the lifeblood of our economic system, is now, more than that of any other key commodity, subject to the whims of countries whose social systems and political objectives are very different from our own. For the first time ever, our whole way of life — even the homes we live in, as Atlantic Canadians recently found to their cost — is vulnerable to the vagaries of rulers of tiny countries half a world away.

We are not only subject to their monopoly power as it affects prices, but also their capacity to turn off the switch on our economy. The new need for security of supply, and the continuing need to manage our international balance of payments, are the real reasons why a national effort to increase our supplies while constraining our demand is essential.

Syncrude and oil sand mining and in situ operations which must follow it, offer the greatest potential of all new energy sources immediately available to us. Even frontier oil and gas resources cannot provide the impact on our energy economy that oil sands development can and will. At cost of $2½ billion, Syncrude will supply 60 per cent as many BTU's to Canadian markets as an arctic gas pipeline costing twice as much. This is not to dismiss northern development, but as a nation we must be sure where our priorities really lie.

For these reasons, it should be a matter of concern that the enormous potential of the tar sands was allowed to lie fallow following the Winnipeg agreement on the future of Syncrude. I do not believe that any one province should have to assume the heavy burden of the entire effort needed to develop the resource; thus, it seems to me that the federal government has a distinct role to play.

This role is best thought of as the creation of a favorable climate for the massive investments required rather than as any direct involvement in the activity. In recent years, the climate for investment of any type has deteriorated dramatically in Canada. Recently, a Conference Board of Canada survey showed that the loss of business and investor confidence is related to a fundamental lack of trust in government. Businessmen cannot be expected to invest heavily in a situation where the financial environment constantly changes with each new intellectual fad of the federal government.

If the confidence to invest in basic manufacturing is not there, how can we expect investment in frontier energy sources to fare any better? The first step of the next Progressive Conservative government in Ottawa must be, and will be, to create a stable investment environment where the roles and guidelines are clearly spelled out.

A stable investment framework is important, but is is not the whole answer. Present costs before royalties and taxes make a very strong case that the government must choose between more oil and more revenue. The world oil price structure and the deductability of provincial royalties from federal taxes are two vital considerations. Until there is a standard tax regime for each and every oil sand operation, it is clear that development will continue to stagnate.

The establishment by the federal government of these conditions to development may not, however, be alone sufficient to generate the massive sums necessary to build more oil sand capacity. It may be that more than confidence is required to raise the billions of dollars in equity and debt that a mining operation today requires. Our Party is looking into a number of options that would extend the federal role still further within a framework of cooperative federalism.

This country simply cannot afford any more delay in getting together the national effort that is required to unlock the potential of this massive energy resource. I believe that private enterprise can do the job. But government must provide the necessary supportive environment.

## Yurko — continued

experiments in Edmonton's Mill Woods. Here, he says, small houses in the 850-square-foot range were produced at prices well below the $55 to $65-per-square-foot price commonly charged for housing in Alberta. "I have indicated that profit and overhead were much higher than necessary in the private sector."

Arguments from the housing industry that AHC paid an unrealistically low price for the city-owned lots involved, only reinforces his contention that developers should be satisfied with less profit on the sale of lots, Yurko claims. "A modest profit was realized on these lots which sold for between $11,000 and $12,000."

While his outspoken criticism of the industry is not likely to win him any popularity contests with builders and developers, Yurko insists it is beginning to have a beneficial effect on housing prices.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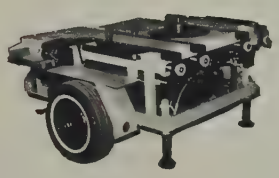

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*The exercise room attached to the gymnasium*

# The campsite is a small city

## Background to life at the Syncrude site

The campsite at Mildred Lake, 30 miles by road north of Fort McMurray, can be compared to a small city. At work peak, its population by day can number up to 8,000 — construction workers, engineers, non-manual office staff, housekeeping and culinary personnel; not to mention paramedics and nurses, security guards, and a fire marshal.

Of these, hundreds come in daily by car or bus from their homes in Fort McMurray and other, smaller communities. But the majority live in camp, their "homes" being 8 feet by 10 feet rooms in 215-foot-long bunkhouses.

When every room is full, the campsite beds down 6,606 people, of whom 252 are women, segregated in their own living areas.

For most of these people, the day begins around 5:30 a.m. By 6:45 a.m., breakfast in the cafeteria is complete. By 7 a.m., the site is humming as the day shift gets to work.

They toil, with thirty minutes for lunch, until 5:30 p.m., Monday through Thursday, until 3:30 p.m. Friday. All told, it's a 48-hour week.

Meanwhile, in the bunkhouses, bullcooks make the beds, clean the rooms (42 to a bunkhouse), and the washing and toilet facilities.

Most workers return to the cafeteria for lunch. However, several hundred each day are at job locations far removed from the central campsite. They make up their own bag lunches as they finish breakfast, and then soup is sent out to them during the lunch break.

Statistically, the daily food consumption during January at the Mildred Lake camps included 11,800 lbs. of meat, 4,600 lbs. of fresh produce, 3,000 lbs. of fresh fruit, 850 lbs. of butter, 530 lbs. of coffee, 3,000 quarts of milk, 1,500 dozen eggs, and 120 gallons of ice cream.

Sub-contractor for the culinary operations is Evergreen Services Ltd., Edmonton. The company also provides the 260 culinary workers and the 150 or so domestic workers, including the bullcooks in the bunkhouses.

When the day's work is done, the camp provides a selection of entertainment and recreational facilities, most being under the overall supervision of a recreation director.

There are movies every night, at $1.00 per head. Recently, French-language movies were introduced on a once-a-week basis.

There are public recreation rooms, several equipped with TV, a gymnasium, pool tables, ping pong, volleyball, floor hockey, cribbage and archery classes.

With summer coming up, fastball and soccer will be added.

The Muskeg Club may close its doors at 10 p.m., but the recreation rooms stay open 24 hours a day, serving endless cups of coffee, tea and hot chocolate, with the compliments of the camp.

No-one, of course, is going to deny that problems arise. "There are over 6,000 people here," added the camp official, "all with minds and wills of their own.

"A point to bear in mind," he added, "is that, although this may be thought of as a remote area camp, in reality it isn't. Work ends at 3:30 p.m. on Fridays, and probably two-thirds or more of the workers leave for two days, either at home, or in the flashier delights of Edmonton and Calgary. They're not confined for weeks on end in suspension from outside contact."

In addition, Mildred Lake employees get rotation leave. The frequency of this varies according to the various union contracts with Canadian Bechtel, the managing contractor. For many, it means that every 30 days a worker can opt for five days away from work. These days are sandwiched between weekends, thus he, or she, has nine days off.

Hundreds of workers, from faraway homes in Ontario, Quebec, the Maritimes, and elsewhere, stay in camp weekends. For them, the movies continue to roll, the recreation rooms remain open, the cafeteria turns out its endless meals, and the Ministerial Association of Fort McMurray sends up ministers to hold Sunday morning services.

And the Muskeg Club opens its doors from 1-6 p.m. and 7-11 p.m. on Saturdays; from 1-4 p.m. on Sundays.


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*A general view of the process area*

# "The way of doing things in the future"

## Pre-assembly venture "courageous"

It's the way of doing things in the future."

That is the verdict of Jim Flower, when he discusses pre-assembly as it relates to construction projects in remote areas. "For example, it would be the only way in which to work on a project such as the Mackenzie delta gas plants."

Flower is manager of the Edmonton office of Fuller-Austin of Canada Ltd. The commercial and industrial insulating company — its Canadian head office is in Calgary — installed a substantial proportion of the insulation on pre-assembled units at Canadian Bechtel's Edmonton Field Operations (EFO).

According to Canadian Bechtel estimates, when the Mildred Lake project is completed, 297,500 square feet of equipment and ductwork, and 239,000 lineal feet of pipe, will have been insulated at the EFO sites before being trucked north to the jobsite.

Describing Canadian Bechtel's pre-assembly venture as "courageous", Flower lists several significant advantages in the concept. At the same time, he cautions that so far as insulation is concerned, accurate financial benefits will not be known until the project is completed and all the figures are tallied.

"In our insulating operation," he says, "it's fair to say that our costs through working locally in Edmonton were somewhere between 30 and 35 per cent lower than if our men had been working on site at Mildred Lake.

"This comes about through higher productivity, and through the obvious savings in not having to accommodate and feed tradesmen at a remote worksite.

"People generally prefer to work near their homes. They like to go home at night, watch TV, be with their families and friends. Take them away from this, and their work suffers."

Flower points out that, even though tradesmen at the Mildred Lake jobsite work longer hours than they would at an Edmonton site, "our research shows that if a man works a 10-hour day, his productivity is not as high as in an 8-hour shift."

There is also the overtime cost factor inherent in a longer work day. "At the EFO sites here in Edmonton," he says, "our insulators worked regular hours."

The cost differential, had overtime been a factor, would have been considerable for Fuller-Austin. At work peak, the company had 100 men employed on its insulating contracts with EFO.

### "Walking time"

Flower confirmed that at pre-assembly sites fewer daily work minutes are lost in what Fuller-Austin defines as "walking time" — those extra minutes spent each day on a longer walk from actual work location to cafetaria for meals, to washrooms, to material storage facilities.

The company has comparative experience in this context in that it was the sole insulating contractor for the Great Canadian Oil Sands construction project in the 1960s.

"When we are tendering for a remote area contract", Flower goes on, "we measure out the distance from the locations where the men will be working to where they are fed and housed, and where bulk insulating materials are stored. These walking distances become significant economic factors in our costing, and can usually be estimated at a loss of thirty minutes' work per man per day."

Flower's words of caution concerning the ultimate financial benefits of the pre-assembly concept relate to two items: damage in transit, and the cost at the jobsite of insulating joints and other specifics that cannot be handled in pre-assembly.

Damage to insulation can occur in loading, trucking, off-loading, and installation at the jobsite. Such damage is extraneous to the insulator's contract. "However," says Flower, "it has to be made good if the insulation is to be effective. And excessive damage could neutralize some of the initial savings."

He concedes that damage to insulation is often cosmetic, and thus need not necessarily be repaired. "The aluminum cover applied over the insulation itself can easily be dented. But the dents do not necessarily mean that the insulation itself has been damaged."

Most of the insulation used by Fuller-Austin on the Mildred Lake project was mineral wool MF Pipe Insulation and ETR Insulation from Forty-Eight Insulations Inc., Aurora, Ill.

Its life is considerable, and Flower sites an oil refinery on which comparable insulation was applied in the 1950s that only now needed replacement.

The life of insulation, he says, depends almost as much on the effectiveness of ongoing maintenance and repair as on the quality of the product.


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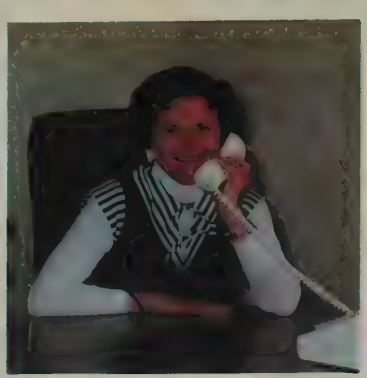

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# Pre-assembly concept saves one million man-hours

*Syncrude a "proving ground for something that could revolutionize construction techniques for future projects in remote areas."*

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The laydown yards at the two sites are fast emptying. Acres of dried mud bear only little evidence now of the recent hive of activity. Workshops, though still humming, have that feel about them that indicates the job is nearing completion — a leisured, confident tempo, free of the tensions that must have been apparent in an operation which, if not totally new in concept, had much about it that was experimental.

In tidy stacks, hither and yon, are slightly rusting components — pipe spools, metal frames, strange fabrications whose shapes once had significance, but which are now surplus, ready for later disposal.

Officially and prosaically in the records, when these sites close down towards the end of the year, they will be known as Sites 2 and 3 of Edmonton Field Operations (EFO), Canadian Bechtel Limited Job No. 9776/10997 for client Syncrude Canada Ltd.

To the men who worked here, however, they will be remembered as the proving ground for the expansion of a concept which, in the words of one commentator, "could revolutionize construction techniques for future projects in remote areas".

The two Sites, located in Edmonton's northwest quadrant, evolved from a general plan developed by Canadian Bechtel to set up Edmonton Field Operations as an offsite support facility to the Syncrude Canada Mildred Lake project.

EFO has been headquartered, as it will be until the project is completed, at a third site, called Site 1, near the city's Municipal Airport.

In broad terms, EFO was established to perform three functions:

To act as an offsite marshalling warehouse, where shipments of material from Edmonton, Alberta and other fabricators could be consolidated from small to large truckloads for movement to the Mildred Lake jobsite, 300 miles away, or stored until required under more suitable conditions than are possible at a jobsite.

To serve as the centre for essential non-manual operations applicable to the entire project, such as finance and accounting, planning and scheduling, material control, procurement, printing, data processing, and

To house the imaginative and visionary pre-assembly operations.

The first two functions have been performed at Site 1. Pre-assembly has been undertaken at Sites 2 and 3.

The feasibility of undertaking pre-assembly operations remote from the Mildred Lake jobsite was under study by Syncrude Canada and Canadian Bechtel from early 1972.

The outcome was the EFO "Plan of Execution", submitted by Canadian Bechtel to client Syncrude Canada in December 1974. This identified manual construction tasks totalling 2,000,000 man-hours which could be performed at locations in the Edmonton area rather than at Mildred Lake. In addition, 2,000,000 non-manual work-hours were listed as being suitable for effective execution in the city.

At that point, the fate of the whole project hung in the balance, due to the withdrawal of one of the participants. The restructuring was completed in January 1975, and the following month Syncrude Canada gave final approval to the EFO "Plan of Execution".

The theory was that, aside from housing extensive office and non-manual functions, EFO could pre-fabricate or pre-assemble a considerable percentage of the construction materials in Edmonton before shipping them north for installation in the plant itself at Mildred Lake.

This work, mainly trade-intensive, included pre-assembly of electrical, civil, mechanical, and piping components, as well as the application of insulation and fireproofing, the construction of huts, and the mass

manufacture of such items as scaffold beams.

Both the manual and non-manual work could be performed under controlled working conditions, largely indoors, by a sophisticated labour force working a normal 35-40 hour week.

By contrast, jobsite assembly is often undertaken under inclement conditions, at a forced pace, by a workforce with a high incidence of turnover, putting in costly overtime, and in part learning on the job.

An additional bonus would be the reduction in costs at the jobsite of housing, food and recreation facilities.

In summary, the "Plan of Execution" estimated that approximately 10 per cent of the total 49,000,000 man-hours required for completion of the Mildred Lake project could be undertaken in this more economical and convenient manner.

That, then, was the concept and, with the "go" sign from Syncrude, a crash program was set in train to turn estimates into actualities.

First, a warehouse leased earlier by Canadian Bechtel near Edmonton's Municipal Airport was put into shape as Site 1, the nerve centre of EFO.

In April 1975, an eight-acre property with extensive shop and yard fabrication space was acquired and became Site 3. Here, the electrical, instrumentation, civil, and mechanical shops were set up.

For the large-scale pipe and vessel pre-assembly, 70 acres of land near Edmonton's Speedway Park were acquired. A half-mile access road was built, as well as a railroad spur, and Site 2 was in being.

Two years later, those three Sites, and the concept they represent, have more than proven their effectiveness.

"Pre-assembly of permanent plant materials is not a new idea," says Del Zambon, author of the original "Plan of Execution" and EFO Manager. "However, our effort on the Mildred Lake project is one of the largest known, and our Edmonton Sites have accomplished many industrial firsts of which we can be justly proud."

Up-to-the-minute estimates now show that, by the time EFO's task is finished, it will have contributed 2,236,300 manual man-hours to the total project. This is approximately 10 per cent more than the 2,000,000 manual man-hours in the original estimates.

Further, according to Resident Engineer John Cain, the effective productivity of the pre-assembly operation has been higher than anticipated. "On average," he told Construction Alberta News, "we have achieved a productivity factor of 90 per cent."

Simplistically, this means that the original 2,000,000 manual man-hours listed in the "Plan of Execution" were completed in 1,800,000 hours. And the 2,236,300 manual man-hours which will have been completed represent over 2,500,000 man-hours measured against a performance factor of 90 per cent.

"It's reasonable to say," says Zambon, "that the more than 4,000,000 manual and non-manual hours performed at the three EFO Sites by the time we're through would have taken approximately 5,000,000 hours at Mildred Lake."

Not surprisingly, Zambon is a dedicated enthusiast for the pre-assembly concept. "And we've only just skimmed the surface of possibility," he believes.

"With controlled working conditions such as we had on the EFO Sites, productivity and quality are easier to maintain than on any jobsite.

"Look at the skilled manpower situation. The pool of people in a city such as Edmonton just would not have been available at Mildred Lake, nor would most of them have even contemplated going there, 300 miles away from their homes and families.

"The EFO Sites bought the project as a whole some schedule insurance against the possibility of not being able to attract sufficient skilled workers to Mildred Lake at the time they were required. In terms of averting a possible slippage in completion dates, this alone was significant.

"Regardless of what happened at the jobsite, we never got behind schedule at EFO because of a shortage of skilled labour."

At the work peak, 1,250 manual and 350 non-manual employees were working at the three Sites. Skilled manual employees included boilermakers, carpenters, cement masons, welders, ironworkers, millwrights, pipefitters, lathers and plasterers.

That peak is now well past. Even so, a recent force report showed a total of 570 manual and 332 non-manual employees.

At one time or another, eleven major shops were established at Sites 2 and 3 to accomplish the EFO pre-assembly objectives. In addition, a 50-booth welder training school was built and operated.

The pre-fabrication and pre-assembly operations included underground electrical ductbanks; formwork; concrete foundations; the insulation and fireproofing of vessels, exchanger, and tanks; the installation of refractory lining in ductwork; the pre-fabrication and pre-assembly of piping and components.

In addition, specific sections of processing plants and pipeways, including structural steel, pipe supports, equipment and instrumentation were pre-assembled into modules for shipment to the jobsite as complete units.

"At Mildred Lake," says Cain, "they were set into their rightful places like pieces of a gigantic jigsaw."

The sheer volume of the pre-assembled items shipped out of the EFO Sites — and the size of many — are enumerated elsewhere in this special Construction Alberta News report.

Even a casual scan will explain why both Syncrude Canada and Canadian Bechtel credit the EFO venture with a big part in keeping the mammoth Mildred Lake project on schedule and within cost targets set way back in December, 1974.

*Pipe bridge module headed along Highway 63 towards Syncrude's Mildred Lake site*

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*A bird's eye view of the extraction plant feed system showing the "box" into which the hoppers will be fitted and the part-roofed-over conveyors to the plant.*

*Another view shows the perspective in relation to the extraction plant (top of picture) where the conveyors rise over the road and enter the plant through tunnels already cut.*

# World's largest materials handling system

What is confidently claimed to be the biggest materials handling system in the world is being constructed at the Syncrude site.

Its function is to feed the tar sand, under controlled conditions, into the first of the process plants — where the bitumen is extracted — and some idea of its capabilities is conveyed by the analogy that in one hour it could fill a football field to a depth of eight feet!

The tar sand, stockpiled by the mammoth draglines and deposited on high-speed conveyors by the giant reclaimers, is transported to two large stackers which pile it on to what is known as a "surge pile", 65 feet in height. The stackers swing round in arcs, so that two arcs of tar sand are formed back to back, the peak being where they abut.

It is at this point where the feed plant, most of whose vitals are immediately below the pile, takes over, for it is this plant which handles the tar sand under control and conveys it to the first basic process — that of extraction, where the separation of bitumen from the sand takes place.

The movement of tar sand from the surge pile employs an age-old mining technique of using a buried hopper structure beneath the pile to control its gravity feed via pear feeders, or hoppers, on to a system of conveyors.

The core, or business end, of the feed system — the hopper structure below the pile — is a gigantic reinforced concrete "box", 242 feet by 200 feet, and varying in height between 52 feet and 64 feet, with a roof slab seven feet thick. Into this slab are inserted the hoppers, funnel-shaped bins, 40 feet in height which project 26 feet into the box. There are 16 of these hoppers, mounted in a 4x4 grid, and each has a pair of gates, mounted underneath, which control the flow of tar sand on to conveyors in the box.

Once the tar sand has passed through the gate opening it falls on to a platform or treadmill type of conveyor which moves it to a transfer point and drops it on to collection conveyors. From here it moves to main feed conveyors which slowly move it to ground surface, and thence, by a rising tunnel which peaks at 58 feet above ground, it is


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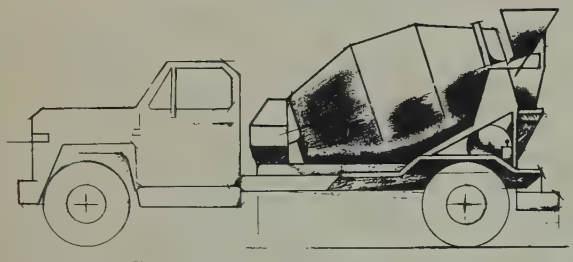

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ed into the extraction plant tumblers.

Thus simply described and abridged the procedure sounds straightforward enough.

But, in detail, the measurements of the amounts of material mined and conveyed, the maintenance of equipment in confined spaces, the cleaning of the plant, the sustaining of air quality and the accommodation and, especially, the safety of operating personnel were problems that turned design and construction into a formidable challenge.

The basic concept of the feed plant was Canadian Bechtel's and Associated Engineering Services Ltd. of Edmonton provided the concept of physical construction and formwork, the final design and engineering back-up drawings.

High in priority among the problems encountered was the construction of the hopper structure, the box beneath the pile, and in particular the seven-foot-thick roof slab.

The roof slab is supported by 42-inch composite concrete and steel columns from a floor, similar to the roof slab, which is stepped, dropping 12 feet in elevation to accommodate the main feed conveyors and the gravity transfer points.

Abutting the structure is the tunnel, 59 feet wide and 32 feet to the apex of its two precast arched roofs.

In the conveyor gallery, which is a system of steel trusses spanning 84 feet on steel supports, the conveyors themselves comprise a 6-foot wide thick belt travelling 550 feet per minute on a series of rollers mounted in a steel frame.

The collection conveyors are 150 feet long, the main conveyors 1351 feet, and the tumbler feed conveyor 120 feet.

The construction of the roof slab of the hopper structure was a big concern for the construction crew.

It weighs more than half-a-ton of concrete per square foot of area, and this weight had to be supported until the concrete hardened and developed its designed strength — taking from four to six weeks.

It was decided that wet concrete would first be supported on a corrugated steel deck, acting compositely with a five-inch reinforced concrete slab; the deck would then be supported by beams which in turn would be supported by girders forming a grid system. The girders would be supported either by brackets embedded in the wall near roof level or by collars suspended from column capitals.

The assembly of the beam girder system was relatively easy, as a huge crane outside the structure could lift them into place. But how to dismantle them after the concrete slab had been poured? Cranes could not be used, and there was no adequate space between the girders and the ceiling for "cherry pickers" to be used — quite apart from the serious danger to the many workers who would be required.

It was with this consideration in mind that the possible utilization of a lift slab was checked — a sophisticated construction technique in which a number of jacks are used simultaneously to raise or lower large, heavy objects by controlling the amount of travel at each jack attachment.

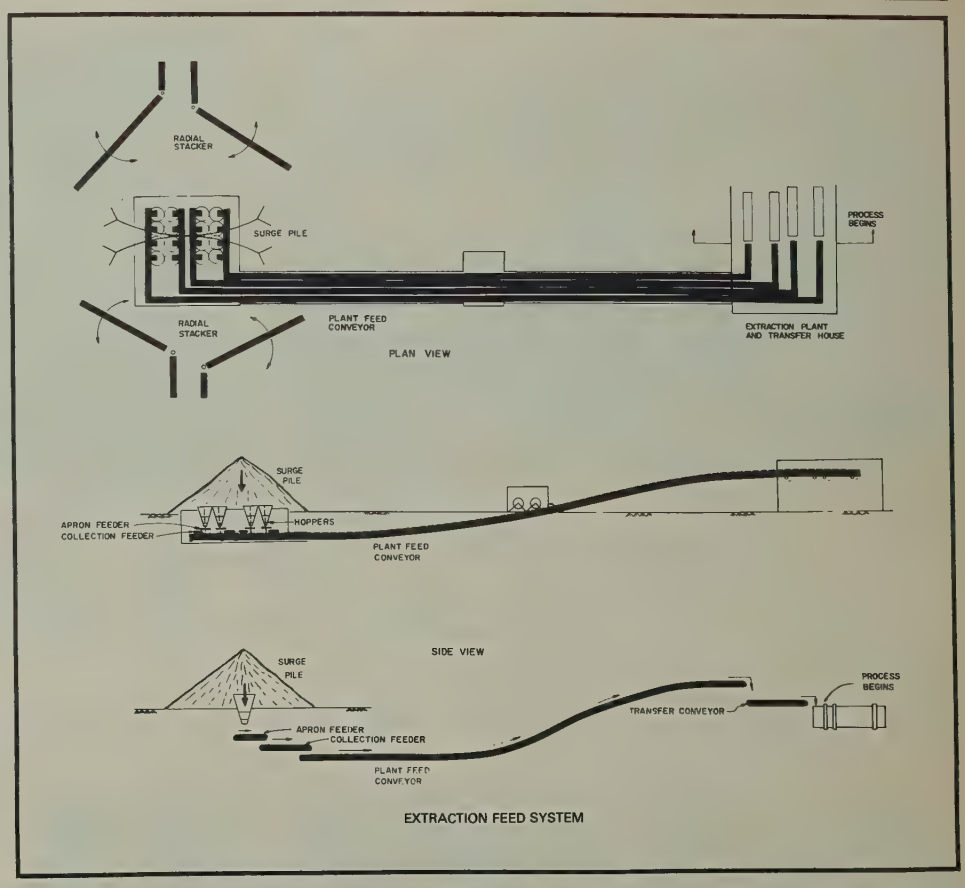
An example is provided by apartment house construction where columns are first erected and jacks set at the tops of the columns. Slabs are poured on the ground on top of each other for the number of storeys.

After the slabs have gained strength they are lifted to the desired height and connected to the columns, the operation being repeated for the number of storeys.

It was decided that the Heede International Heede Lift Climbers would be best suited for lowering the temporary steel work. With this system it was possible to place a number of jacks on top of the newly-constructed roof slab and connect jack rods to the girders below through pipe sleeves that were embedded in concrete.

As the jacks were engaged the collars around the pipe column and brackets at the wall end were set free ready for the lowering operation.

Following this, the lowering operation was done from the top of the concrete slab and only a minimum number of operators were necessary for the whole operation.



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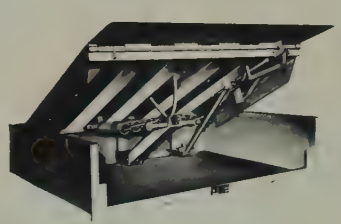

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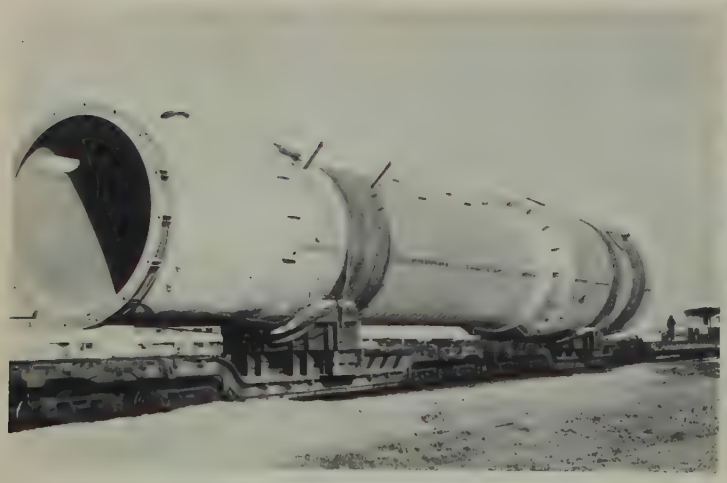

# Northern Alberta Railways ready for growth

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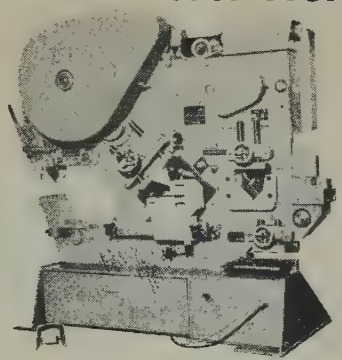

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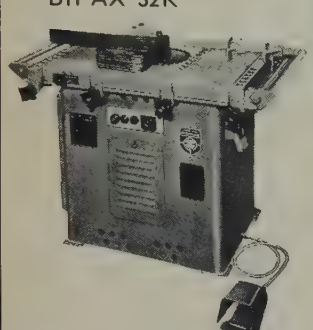

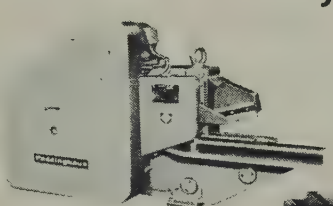

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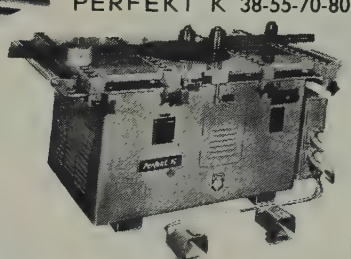

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By the end of this year, all but 70 of the 300 miles of the Northern Alberta Railways' track between Edmonton and its Waterways (Fort McMurray) terminal will consist of 100-lb. rails. (Those 70 miles comprise 30 miles of 60-lb. and 40 miles of 85-lb. rail.)

In railroad parlance, this means a yard of rail weighs 100 lbs., upgrading most of the line's load capacity to 220,000 lbs. per four-axle car from the 176,000 lbs. limit imposed by the lighter 60 lb. rail used when the track was originally laid.

Related to future operations, the upgrading is of considerable significance, since few people expect Syncrude's Mildred Lake project to be the last plant to be built for the extraction of the black gold of the Athabasca tar sands.

Aside from prospective northbound hauls derived from such future plants, and from northern development in general, executives at NAR wait patiently for the world's sulphur market to perk up. When this occurs, they see southbound shipments of sulphur — as well as other bulk by-products, including petroleum coke — increasing their freight tonnage on the line.

NAR invested $400,000 in building a sulphur loading facility at Waterways when the Great Canadian Oil Sands operation went on stream. It had moved 108,000 tons of sulphur from the GCOS stockpile before the bottom fell out of the market.

Since then, the GCOS stockpile has been growing daily. When Syncrude's operation is in full swing, the sulphur reserves in the tar sands region will increase even more rapidly.

(The Alberta Department of Transportation, aware of the vast unused reserves of sulphur, has already conducted a series of trials in which sulphur is mixed with asphalt for road surfacing application. A second series of trials will be initiated this summer. Impetus behind the venture is the appeal of sulphur's lower costs, and its use as a way of helping conserve the province's asphaltic materials.)

NAR has been an important carrier of material, equipment, and components into the Syncrude project. Since construction started, the company has shipped a contracted 100,000 tons to its facilities at Fort McMurray.

Here, either at the Waterways terminal or at its specially-built intermodal yards at nearby Lynton, loads are transferred from rail to road for movement over the Athabasca River and up the last 30 miles of

*Northern Alberta Railway's ferry at Fort McMurray*

highway to Mildred Lake. The road haul contractor is Pe Ben Industries Limited.

Most of these shipments have been routine by railroad standards, being despatched on schedule freight runs. But the exceptions were sufficiently numerous to warrant the establishment of a special department at NAR to handle them.

During the period of approximately two years, managing contractor Canadian Bechtel supplied to this department a total of 398 original drawings of units to be shipped by rail. In each case, the drawing was matched against possible car-loading facilities, available routes, and freight schedules.

A novel and integral service offered in the contract with Canadian Bechtel was NAR's acceptance of responsibility for safe delivery of units from their points of origin to Edmonton and on to Mildred Lake. Usually, this responsibility falls on the fabricator or shipper at the point of origin.

The points of origin NAR had to cope with ranged all over Canada and the United States, and the company's special department communicated with scores of railroads across the continent checking and double-checking routes and clearances.

A key factor in many cases was the access from fabricator's plant to the nearest tracks. "We had to make sure that a fabricator didn't build a boat in the basement," comments NAR Traffic Manager A.J. Dove.

In the event, an average of four revisions were made to each of the 398 drawings. Certainly, many of these came from Canadian Bechtel as changes were made in the design of units themselves. Many, however, were made by NAR to ensure a particular unit's safe arrival.

"In some cases," added Dove, "acceptances of bids on tenders were affected by impossible shipping situations. And it was in the New England area that the most serious clearance challenges occurred, due to the closeness of the country and the relatively cramped right of way."

"The major problems," added NAR's Chief Engineer Lee Halasa, "arose with tunnels, bridges, signal systems, and track curvatures.

"Tunnel heights and widths are constant factors. You can't change them, and loads had to be designed to travel within their limitations. If these were insufficient, another route had to be worked out, or the unit's design amended.

"Similar situations arose with bridges and their weight-carrying capacities."

Track curvatures present problems of a special kind, especially if a load is excessively long — as with one 188-foot-long vessel — and has to be carried on two railcars.

For example, as the cars round a bend, the load itself becomes, by analogy, the taut string across the arch of a bow, obstructing a parallel track. Or, the overhang of a long load swinging round a curve becomes an effective battering ram capable of knocking down poles or other trackside furniture.

Curves demand strict attention to axle load weights. Incorrect loading, or neglect in adding ballast to lower the centre of gravity, could cause a unit to topple.

Major traffic centres, such as marshalling yards or complex track systems in and around urban areas, had to be carefully checked out for clearances. Trackside buildings, signals, light standards, control fixtures can all provide hazards for loads with excessive dimensions or weight.

In a number of instances, such as over bridges and in busy track complexes, shipments bound for Edmonton had to be guided through at walking pace, with supervisors watching every clearance hazard.

"On more than one occasion, we literally got through with an inch to spare," says Halasa.

But there were occasions when even a one-inch tolerance was considered insufficiently safe. On one relatively short haul from a fabricator's plant south of Edmonton, a unit which had to travel two-and-a-half miles as the crow flies, had to be routed over 25 miles of track to ensure its safe delivery.

However, one of the jobs NAR is most proud of is the shipping of girders for the bridge that had to be built across the Athabasca River at Fort McMurray.

Each girder was 144 feet long and 11½ feet high. The possibility of damage from whipping was acute. "We loaded them in fours, side by side on the railcars, with stiffeners to hold them steady," says Dove.

"They arrived without a dent. We were proud of that," he added quietly.

And, of course, there were the four 370-ton vessels from Italy. But that's another story.

NAR is a private company, owned 50-50 by Canadian National Railways and Canadian Pacific Railways. Its track system is an amalgam of what originally were the Edmonton Dunvegan and British Columbia Railway, the Alberta and Great Waterways Railway, and the Central Canada Railway.

The line to Fort McMurray is just one of the routes operated in northern Alberta and British Columbia. It is used mainly to haul freight, especially fuel oil, for trackside destinations and for transshipment from Fort McMurray by barge up the Athabasca River to destinations in northeast Alberta.

# Common base for environmental studies

Federal and provincial government departments and agencies involved in gathering data on social, economic, and cultural concerns in North-east Alberta have been asked to use a common base for their studies.

The request, made by Walter Solodzuk, deputy minister of Alberta Environment, and chairman of the Alberta Oil Sands Environmental Research Program (AOSERP) Steering Committee, followed a study funded by AOSERP through its Human Environment Technical Research Committee, which outlines the availability, types, and format of social, economic, and cultural data pertaining to the Athabasca oil sands area.

The AOSERP is a 10-year research agency established by Alberta and Canada to formulate practical solutions to environmental problems caused by the development of the Athabasca oil sands. Through a two-member steering committee, AOSERP reports to the minister of the Environment for Alberta and the minister of Fisheries and Environment for Canada.

The study's review found that in social, economic, and cultural studies, there has been no common approach to geographical and population units. The Statistics Canada census was found to provide the most detail, the most complete coverage of the study area in North-east Alberta, the smallest statistical areas, the greatest consistency in data and data collection and the most regular collection.

The AOSERP report, "Structure of a Traditional Baseline Data System", recommends that all provincial government agencies and departments use the Statistics Canada census units when gathering data on the human environment in the Athabasca area.

A second recommendation is that a common small-area plan, compatible with the Statistics Canada census units, be permanently outlined for the AOSERP target area.

The third recommendation is that all available data be geographically referenced to that common small-area plan before development of a baseline data system is begun.

To study the effects of oil sands development on the human environment, AOSERP required a catalog of the available survey results. The research was to determine whether appropriate data existed to develop a complete statistical inventory for the study area. To be usable, data from different sources should be suitable for comparison.


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# Building the pipelines

*Summer completion for oil and gas lines*

*Pipeline construction — simply described, the pipe is "strung" along the pipeline route...*

*...a ditching machine excavates the trench for the pipeline...*

*...the lengths of pipe are welded together, and...*

*...the welded pipe is lowered into the trench. The trench is then in-filled*

The construction of pipelines serving the Syncrude project — one, a 22-inch diameter oil line system linking the plant with distribution facilities in Edmonton, and the other, a 16¼inch gas line from Atmore to bring natural gas to the plant — are either complete or well up to schedule.

The oil line is the property of the Alberta Energy Company. Natural gas brought in via the gas pipeline from Atmore will be used for feed to the hydrogen plants, for pilot gas for fired heaters and boilers and to supplement process gas in the fuel gas system in the plant.

The northern half of the oil line, from the La Biche area to the Syncrude site, scheduled as a winter job to take advantage of the frozen muskeg, is complete, and the contract for the southern half, scheduled as a summer construction job, was being awarded this month for completion by the end of August. This will be in time for the line to be used, initially in reverse, to transport fuel northwards for the initial start-up step of the plant.

The contracts for the northern half of the line were awarded last December to two Edmonton pipeline companies, Bannister Pipelines and Pe Ben Pipelines. Bannister worked from La Biche to the Mariana Lake, and Pe Ben from the Mariana Lake area to the Syncrude site.

On the Syncrude lease itself, where both the oil line and the gas line systems are complete, construction was carried out by Marine Pipeline Company of Calgary.

The line was completed last month and the system is currently being commissioned.

Both the oil line and the gas line are following the same route as far as Atmore. Environmentally viewed, this avoids unnecessary disturbance, and the Alberta government, who made the routing stipulation, are being guided by long-term considerations in the light of possible additional tar sands production plants that would also need pipeline facilities in due course.

Pipeline construction has become in these days a highly sophisticated, if fairly common, procedure, and under normal conditions of climate and terrain construction crews can cover several miles in a day.

When the pipe is delivered to the site it is strung out in individual lengths along the route, while a ditching machine prepares the trench in which the line is finally to be buried. The lengths of pipe are then welded together, sealed and wrapped against corrosive elements and lowered into the trench, the pipe being long enough to be pliable over a considerable distance. Once lowered, it is tied into position and the trench is filled in. No visible trace of the pipeline remains, except on engineers' plans, and the whole area can be reseeded if necessary.


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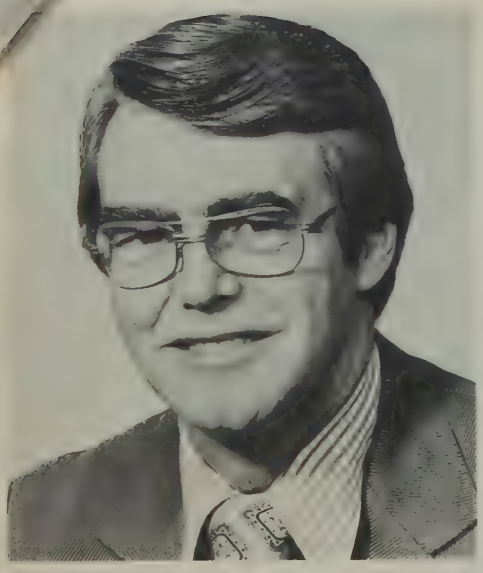
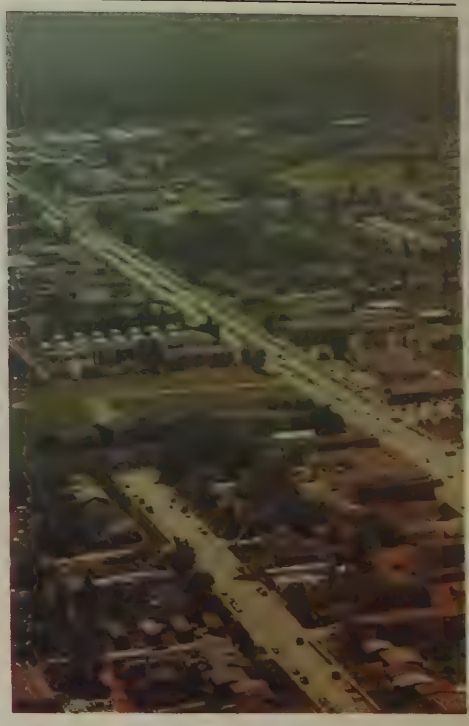


C.A. (Chuck) Knight

# "A most interesting municipality"

*Fort McMurray's development third in province*



Downtown Fort McMurray today

"Fort McMurray is the most interesting municipality that any citizen could ever hope to live in. Its rapid growth has created a wide range of interests that have resulted in the involvement by many newcomers to the town who have never previously considered playing such an active part in a community such as they have here. In the 20 years since I first arrived in Fort McMurray I have developed an air of optimism for the future of this town and it continues to fascinate me as it unfolds into what will be one of the major municipalities of the province, with the possibility of it becoming the third largest as more and more oil sands plants come into operation."

Certainly, if statistics are anything to go by, these projections by the mayor of Fort McMurray, C.A. (Chuck) Knight, are not without substance.

In 1961 the value of building permits approved was just over $1.5 million. In 1976 the figure was just under $90 million.

With a population of 17,500, tenth in the province, this building permit record puts Fort McMurray into third place in development, right behind Edmonton and Calgary and well in front of any other municipality.

Tracing these statistics back through recent history, the figure for 1976 more than doubled that of 1975, the previous big jump having come in 1974 when it increased to over $45 million from the 1973 figure of $5.4 million. This was due to the incidence of the Syncrude operation. The previous biggest leap was in 1967, coinciding with the GCOS project, when it rose to $7.7 million from the $2.7 million of 1966.

The great proportion of the $90 million value in permits in 1976 — representing some 77 per cent — was for housing of all types. Commercial development, at $8.6 million, accounted for 9.5 per cent; industrial, at $6 million, 6.6 per cent, and institutional, at $5 million, 5.5 per cent.

The balance, at around $1 million, was represented by improvements to existing buildings.

It is estimated in some official quarters, according to Knight, that by mid-1978 Fort McMurray will have a population of around 31,000, though in the light of the indications given by Syncrude regarding numbers of employees, he himself considers this projection to be too high. "Normally, in the matter of goods and services supplying an industrial centre, you look to a one-to-one ratio. In other words, if Syncrude has 2,500 employees who, with their families, give us a total of 10,000, one should be able to project a figure of 20,000, taking into account the provision of all the goods and services necessary to maintain that number. However, in this case this is high because much of the Syncrude figure has already been discounted, so the ratio is more likely to be, not one-to-one, but .7 or .8-to-one.

"But that," Knight adds, "is only the Syncrude scenario. We have had projections done on the basis of Syncrude plus one, plus two, and so on, and we have arrived at an eventual population figure of around 100,000; but before we think in terms like that we have to wait until decisions are made on additional plants. The point is that this is the breathing space that we must have between the time one Syncrude project ends and another begins."

Judging from past experience, that breathing space is necessary if the best interests of good planning, particularly in housing accommodation, are to be served. "At a time of rapid expansion," says Knight, "you have to make some temporary arrangements, but if you are not careful they have the habit of ending up being permanent."

Originally, when the town's development really began to get into its stride, there was a lowering of standards under the pressures that were suddenly being brought to bear; and "it was difficult to eliminate them once they were in place. To some extent the problems still exist, particularly with regard to temporary accommodation."

So far as the future is concerned some pretty big projects are envisaged, not simply in housing but mainly in institutional, commercial and recreational and social construction schemes.

Starting currently is a downtown two-tower provincial and civic office complex, and already agreed by the province is a $41 million extension to the general hospital.

The town is working towards a major recreational facility on MacDonald Island, which in cost will run as high as $15 million, though phased as funds become available, and which will comprise an 18-hole golf course, 12-set curling ice, handball and squash courts, banqueting rooms, a swimming pool, a theatre, an arena and nurseries. In addition there are to be four football diamonds which will be the equivalent in facility to anything to be found elsewhere in Western Canada.

Also planned for the town are soccer, rugby and cricket pitches, children's playground areas, hiking trails and fishponds.

"We have just completed a 750-student high school," the mayor goes on, "and consideration is already being given to increasing it or building another. The Department of Advanced Education has recently opened up a multi-million heavy equipment facility at Keyano College here in the town and plans are underway to upgrade

*(continued on Page 51a)*

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*Left - Beacon Hill, one of the Fort McMurray development areas.*

*Right - Construction underway on Northward's two-tower, eventually three-tower, apartment complex in River Park Glen.*

# Housing for the compa

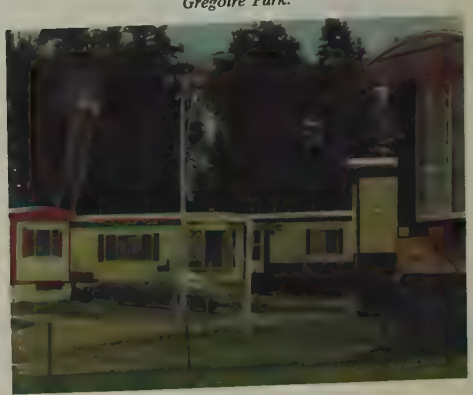
## Northward Developments' bustling activity

*With today's lifestyles and ease of living in mind, Northward Developments have devised a wide choice of living units for purchase or for rental by Syncrude employees in four principal areas of Fort McMurray.*

*Part of one of the townhouse complexes which are built in two separate designs, a multi-level and a conventional two-storey. There are built-in garages with direct access to the foyers.*

*Above - Patio homes under construction at Abasand Heights.*

*Below - A section of the mobile home area providing temporary accommodation in Gregoire Park.*



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# y's people

## Fort McMurray

The development of the tar sands industry, first by GCOS and more recently and on a much greater scale by Syncrude, is changing the face of Fort McMurray.

Statistically, this has been reflected in the value of building permits which, at nearly $20 million for last year alone, put the town third highest in the province behind only Edmonton and Calgary.

Environmentally, there is now much more to be seen of what, in the recent past, has been simply envisaged by developers and projected only on the town-planners' maps. Fort McMurray today presents a hive of bustling activity with new housing estates, apartment complexes and ancillary recreation centres, shopping malls and play areas taking shape right across the landscape.

Foremost among the developers, and wholly pre-occupied with Syncrude housing and concommitant social and recreational amenities, is Northward Developments Ltd.

Northward is the sister company of Syncrude Canada and, owned by the same shareholders, it is under contractual obligation to Syncrude to provide housing accommodation for purchase or rental by Syncrude employees. In addition to providing the housing, Northward is also charged with the management and administration of the housing inventories on behalf of Syncrude.

As the property developer and the owner of all the lands it is developing, Northward is the vehicle on behalf of which the necessary finance is arranged — which, so far, has been done totally through Alberta Home Mortgage Corporation, with secondary finance also provided through the provincial government.

A summary of Syncrude's housing requirements to 1978 in Fort McMurray gives a total of 2,875 units, and the units already supplied, under construction at this time or scheduled for the immediate future, number 2,638. By "units" is meant single family dwellings, link housing, which constitute small lot development, townhouses and apartments, which are basically for rental, and mobiles. (Mobiles are not part of a permanent policy and are used principally to provide accommodation for employee training and upgrading, and this use is being carefully monitored).

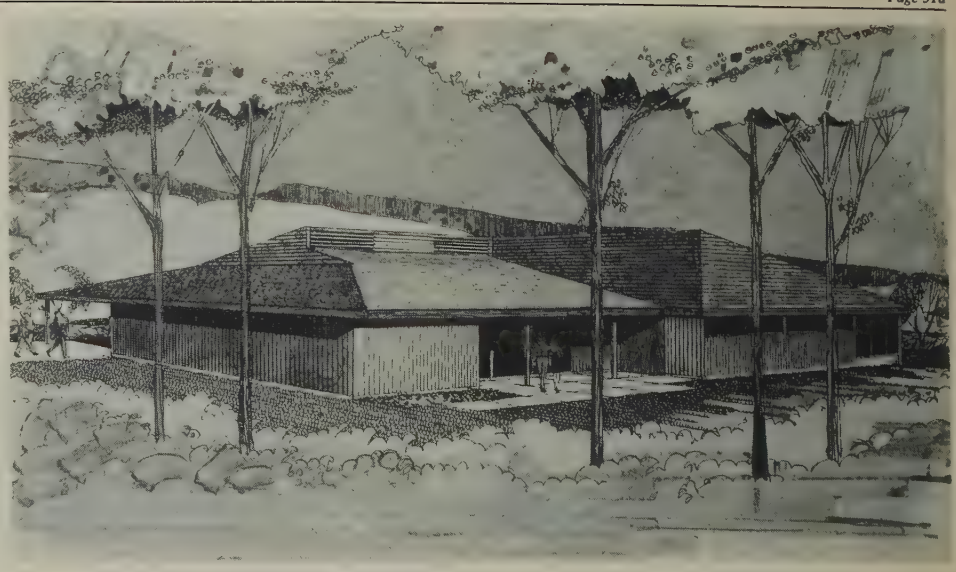
Under the company's housing policy units are sold to employees under a sale agreement by which Northward remains the registered owner for 10 years. The company operates a purchase assistance scheme that offers a maximum $32,500 interest-free loan in respect of down payments — this loan being amortized over 25 years. Second mortgage finance up to $37,500 is available at the current prevailing interest rate. A further advantage to purchasers is that no legal or real estate costs are involved.

The sale agreement contains provisions protecting employees against downside risks and compensating them for appreciation in value and for any improvements they have made if the home is sold back to the company before the 10-year period expires.

John Elson, vice-president housing and urban development for Syncrude and vice-president of Northward Developments, makes the point that employees and their families coming to live in Fort McMurray should have a choice of lifestyles, and that the company's role should extend beyond the provision of houses into social and recreational amenities. Its urban development functions involve close liaison with the Fort McMurray community and it has a stake in ensuring that Fort McMurray has distinct attractions to offer prospective residents in terms of total community and job involvement.

Northward is principally pre-occupied with four areas of the town — Beacon Hill, Thickwood Heights, Abasand Heights and Lower Town.

At Beacon Hill and Thickwood Heights the company is building 540 single family detached houses and 706 townhouses; at Abasand Heights, which represents the company's biggest presence in the town, 350 single attached houses, 443 townhouses and 301 apartments, and in Lower Town, in a development known as River Park Glen, work is proceeding on a two-phase, $40 million three-tower apartment complex on a 20-acre site. The first phase, costing around $28 million, is providing 500 residential units; the second phase will provide 204.



*Social and recreational pursuits are well provided for by Northward in centres with facilities for community activities, games, crafts and hobbies--and in some cases complete with swimming pools and nurseries.*

## Fort McMurray — continued

the academic facilities at the College in connection with, and in close proximity to, the new high school.

"Also recently completed is the $5.5 million water treatment plant, and we have already started on a $5 million sewage treatment plant.

"Many new shopping facilities will be coming on stream this year. A major addition to the existing Peter Pond complex will include a two-storey Hudson Bay store, and many other commercial outlets are to be housed in an all-weather mall.

"Work on another shopping centre in Franklyn Avenue is scheduled to start shortly, and in fact there will be neighborhood shopping centres started this year in all the new residential areas.

"We hope to start a million-dollar arena in Thickwood Heights, and planned for Thickwood Heights, too, are some additional elementary schools."

All of which, in conclusion, brings us back to the mayor's projections that Fort McMurray will soon be one of the major municipalities of the province — and perhaps the third largest in due time.

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Bill Sande

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# The other si...

## The vital need for co...

*"There is another vital 'energy alternative'—and that is to reduce our energy consumption. We have assumed that the era of cheap and readily accessible energy would last forever. We developed consumer habits that now threaten our future security. It's now time for all of us, as consumers, to take a hard look at those habits and start making some different choices, while we still have choices to make."*

Anyone who has been paying attention to current affairs for the past several years knows that we in Canada have entered a disturbing new era that is going to profoundly affect not just our energy supply, but indeed the performance of our economy and the shape of our entire way of life.

"When the first signs of this change were noticed, some people labelled it as an 'energy crisis'. We now know that this label was an inadequate description of a whole range of basic changes in our world. These changes don't just affect energy; they affect raw materials of all kinds. They affect the incomes of entire countries; they affect the ways we are going to work and play. And to call them 'crisis' is wrong too, because it infers that if we can only find a solution, the situation will go away. But there is not just one solution, and the situations are not going to go away. Unless students of the direction of world events are completely wrong, our whole world is dramatically changing, and the good old days of the 1950s and 1960s, when it seemed that we here in Canada could go onward and upward forever, are not going to return.

"One subject I want to examine is the interconnectedness between our need to produce more energy and our equally strong need (which we haven't yet really recognized in Canada) to consume less.

"We talk of 'energy alternatives', and this usually means the various energy sources and technologies from which Canadians will have to choose, whether nuclear, thermo-nuclear, geothermal, solar, biomass or whatever.

But there is another vital 'energy alternative' — and that is to reduce our energy consumption.

"We — and by that I mean not only the energy companies, but everyone in Canada — have historically not thought much about this second alternative. We assumed that the era of cheap and readily accessible energy would last forever. We developed consumer habits that now threaten our future security. It's now time for all of us, as consumers, to take a hard look at those habits and start making some difficult choices, while we still have choices to make.

From 1960 to 1974 Canada's energy consumption grew at an average rate of 5.5 per cent per year. If this growth rate continued for 50 years, our daily petroleum consumption would grow from approximately 1.8 million barrels per day to 26.2 million. At a one per cent growth rate, the daily consumption would be 3.0 million barrels a day. Even this could be a very significant challenge. The full impact of the need for conservation has not yet hit Canadians.

"Let us look at energy supply and demand forecasts for Canada.

"Several years ago, I had to start thinking about energy sources other than conventional crude oil and surveying the literature, I was provided with considerable food for thought. One article in the Scientific American seemed to sum up the situation quite well for the United States. Briefly put, it concluded that they are going to run out of conventional oil; that coal and nuclear power would play significant roles in future energy supply, and that other sources such as wind, tidal, geothermal and solar would not be significant contributors, at least not to the same degree as coal and nuclear power.

"I am not going to try to predict when Canada will run out of conventional oil. I will accept the fact that we will.

"Today in Canada we consume 1.8 million barrels a day of petroleum. Our proven conventional oil reserves are about 8 million barrels. At a one per cent per year growth rate over the next 50 years, we would have to find and produce 42 billion barrels, more than five times our present proven supply.

"Even at zero growth rate for the next 50 years, we would have to find and produce 33 billion barrels of oil!

"Since we're all interested in the Athabasca Tar Sands and heavy oil, let's turn our attention to the role heavy oil may play in our future supply picture.

"Our mineable reserves of tar sands are estimated at some 26 billion barrels and could be a significant contributor to a 50-year demand of 33 billion barrels at zero growth.

"The in-situ reserves total some 950 billion barrels in place. The previous demands would amount to only four to six per cent recovery of the total reserves. I'm sure that we are going to do better than that. At ten per cent recovery we might anticipate 95 billion barrels of heavy oil recovery.

"Consequently, with the combination of mining and in-situ technology and with modest growth and the conservation ethic, we do have a significant supply of petroleum and we haven't included improved secondary recovery on conventional oil or new discoveries. The tar sands and heavy oil could make a significant dent on our future needs and we should be developing them more rapidly. However, the lead time to put them into production is great. And the resource we're shortest of today in the search for energy is time.

"Incidentally, with respect to any new discoveries we might anticipate in the Arctic or off-shore Atlantic, they put me in mind of my golf experience in rain storms. I always get caught on the hole the furthest away from the clubhouse; and so it is with the frontier exploration. When we find oil, it will be costly to get it to the demand centres, just as costly as mining or in-situ production from the tar sands.

"What will happen when we run out of conventional oil? Let us examine the major alternatives and their implications. Here is a typical shopping list with some interesting facts.

"In nuclear power, Pickering in Ontario generates 2,000 megawatts of electricity, or about 30,000 barrels per day of oil energy equivalent. To build it, in the Syncrude time frame, would cost over $2 billion.

"For coal gasification, a world scale plant would produce about 40,000 barrels per day of energy equivalent and would cost in the order of 1.5 to 2.0 billion dollars. A coal liquification plant would produce 100,000 barrels per day of oil equivalent energy at a cost of 3-plus billion dollars.

"Future heavy oil plants, like Syncrude, will cost $2 billion plus and produce 125,000 barrels per day of energy. In-situ plants were just as costly when I was looking at them, but they do have the potential for cost reduction. However, they also have some additional risks in predicting well productivity.

"As to solar power, biomass and geothermal power, none of them offer much hope as short-range solutions to our energy needs — either because of geography, geology, or the infant state of the technologies. They may help locally, but not for some time.

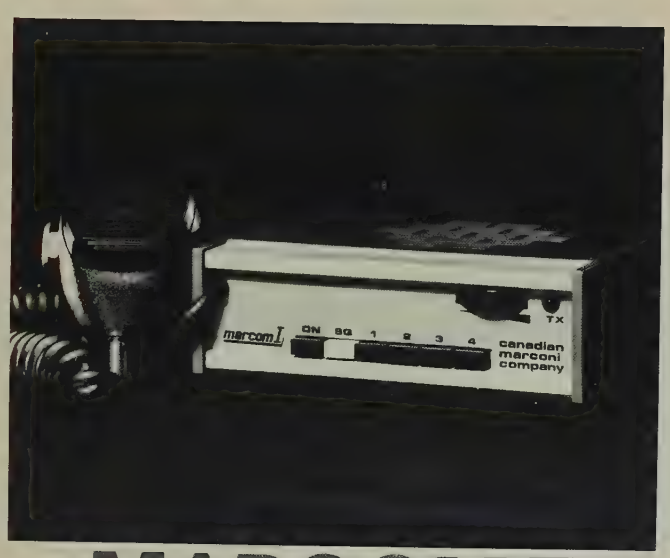
"So what does the future hold when we consider our shopping list of alternatives to conventional oil? It calls for large capital requirements — too large for a single company. Consortia will have to be formed.

"Small increments of energy are produced — 30,000 to 125,000 barrels per day.

"The Syncrude project, started to break ground in late 1973 and will not be totally operational until 1979 — five solid years of construction — and the other projects on the shopping list have similar characteristics.

"Let us at this point examine the pace at which the heavy oil plants might be constructed. Assume we wanted to supply today's demand of petroleum with synthetic crude and, for

*(continued on Page 54a)*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next few years, Canada will be unable to meet its
ation, important statements have been made by two
o are thoroughly convincing in the arguments they put
of Syncrude Canada Limited, and Dr. Ian Efford, director,
Energy, Mines & Resources. These articles are quotations
nadian Institute of Mining and Metallurgy, and Dr. Efford

# le of the coin

## ervation of energy

*Dr. Ian Efford*

*The incentive to reduce unnecessary waste is quite striking. If we have an average growth rate in energy of two per cent between now and 1990 instead of a four per cent rate, the difference is equivalent to the output of six Syncrude plants, plus 80 per cent of the expected annual Canadian output of the MacKenzie Valley Pipeline, plus 15 Pickering-sized nuclear power plants, plus 10 million tons of bituminous coal. An amount worth saving!*

Many Canadians have lost sight of the fact that there is a serious energy situation that must be dealt with by effective measures. The energy supply situation is clouded by uncertainties and we can no longer be complacent about continued supplies, certainly not continued supplies at low cost.

We've come a long way since late 1973 in realizing the potential supply of energy in Canada. For decades we considered energy growth as almost being part of our country's heritage. Industry considered unlimited energy use as something that was an accepted fact of business life and few thought that we could actually manage our processes and our behaviour to effect considerable savings. Energy consumption was considered as fixed — something that could not be adjusted. Until 1973, the consumer seldom saved energy since it was abundant and cheap. Now it is neither abundant nor cheap.

On the supply side, the energy picture in Canada is not very clear although some are extolling cautious optimism. Cheap domestic sources of oil and natural gas are rapidly running out. Even in "energy-rich" Alberta, the future for low-cost sources is uncertain and national energy policy is forced to downgrade reliances on them for future planning. There are other sources available, admittedly at high price, such as the Tar Sands and the Arctic. The extent or cost of these resources, however, has not been fully determined although we do know that the costs for extraction and delivery are estimated as being extremely high relative to conventional sources. Furthermore, we obviously have problems with delivery; it is still to be decided whether an Arctic pipeline will be built.

On the east coast, we are dependent on imported crude oil and this means we are almost totally dependent on the expensive foreign supplies.

### Coal, hydro-electric, nuclear

Coal is relatively abundant in British Columbia, Alberta and the Maritimes but there are environmental problems and problems of deliverability since the major deposits are far away from the main markets.

There still is much hydro-electric potential but, as seen by James Bay, etc., the costs of the projects are extremely high and many provinces are finding financial difficulties when considering such projects. New potential is also considerable distances from major markets and transmission costs and losses are high.

### Nuclear costs high

Nuclear potential is good and we have one of the world's best generating systems. Capital costs, again, are high and are constraining rapid expansion of the nuclear program in some provinces and there are environmental and storage problems that have to be considered.

On average, energy-related investments amounted to approximately 3.5 per cent of GNE over the period 1950-1975. To meet future requirements, however, it has been estimated that for the period of 1976-1990, energy- cent and 5.2 per cent of GNE, with a high of 6.5 per cent for the period 1980-1985. These large projected energy expenditures raise questions in terms of real resource markets and financial markets since some sectors of the economy will have to give up the additional two per cent or so of GNE to accommodate the energy expenditures.

Those who believe that Canada should increase its level of energy consumption might also be asked to indicate where the resources to do so will come from: decreased spending on education, on defence, on social security—or alternatively, how structural adjustments will be made to accommodate the additional activity.

### Utilization inefficient

I do not want to paint an overly-pessimistic picture of supply.

No doubt energy supply potential exists but it will be expensive and, over a considerable range of energy usage, the reduction of energy demand through conservation is less costly, will yeild results more quickly and will have less associated risk than will expansion of energy supply by a comparable amount through greater development of domestic sources or increased imports.

While the production of energy is requiring more and more capital, manpower and other resources, and is causing social and environmental problems, I believe that Canadian utilization is so economically inefficient that, even at current energy prices, the energy demand growth rate could be cut to below two per cent per year. This is no magic figure and the Energy Conservation report, which my Office is now preparing, will analyze sector-by-sector the justification for such a growth rate. However, although we can achieve growth rates in overall energy consumption which are around two per cent they will only be achieved if we put as much effort into increasing the efficiency with which we use energy as we have put into supplying and delivering energy in the past.

*(continued on Page 55a)*


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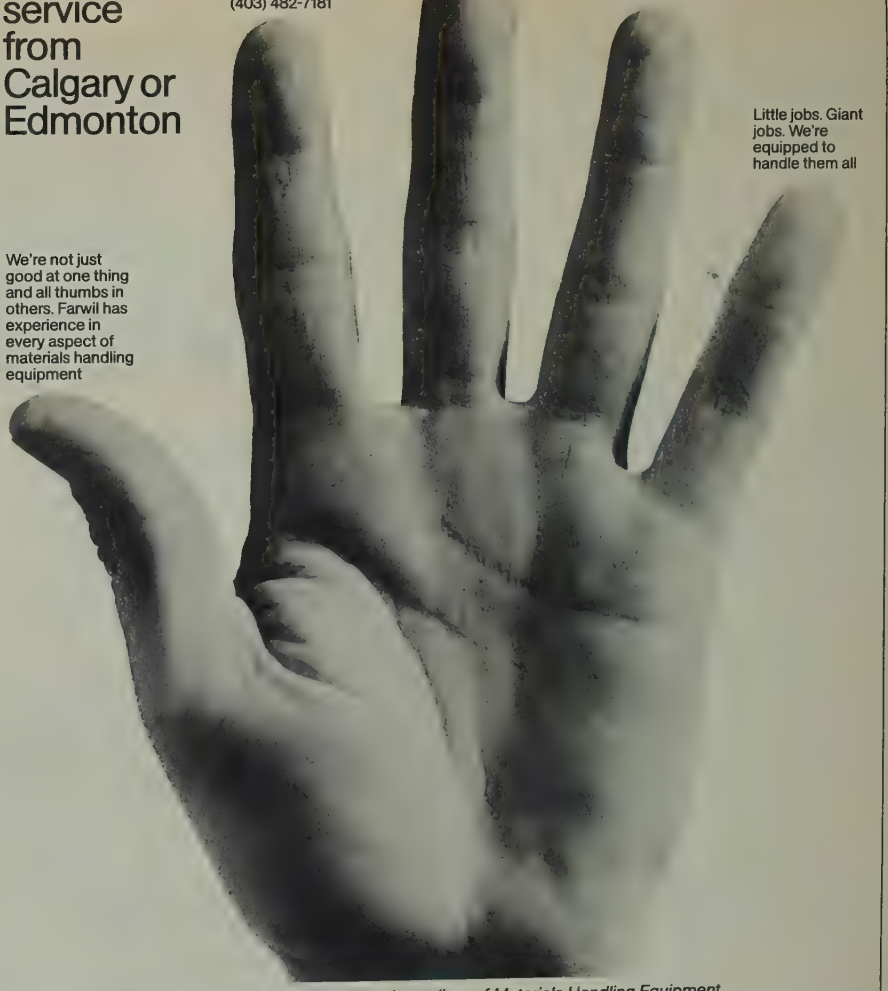

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## Bill Sande — continued

easy calculation, assume 100,000 barrels per day of synthetic crude production per day. With a demand of 1.8 million barrels a day, this means 18 plants. Assume we would build one every three years. Also assume each plant has a 25-year life. After we have built the eighth plant, year 24, we would have to replace the first plant. Now we are building two plants during each three-year period and we would continue at this pace from the 24th year.

"Perhaps if, in the 24th year, we alter our initial assumption of 100,000 barrels per day plant size to 200,000 barrels per day size, we could eliminate the heavy construction schedule after year 24.

"Consider AECL's forecast of nuclear growth in Canada — 100,000 megawatts by the year 2000. Fifty Pickerings in 25 years! Again a large labour force, and a long construction period. Two plants per year? I don't think we can do it.

"Filling our future energy needs with a combination of fossil fuel and nuclear plants poses some interesting challenges. Albertans must develop the technology to economically recover heavy oil from the vast reserves. This technology is uniquely Canadian and, if accomplished, would be comparable to Canada's accomplishment with its nuclear technology.

"These large plants must operate predictably and reliably. High mechanical integrity must be realized from the results of design, fabrication, construction and operation.

"With a 'Buy Canadian' policy for materials, a very large secondary industry will develop in Canada requiring the country's total resources and not just the resources of any one province.

"The pace of construction will have to be managed so as not to overheat the economy, for we all know the consequences of this action.

"Within our total economic priotities, the politician will have to harmonize the priorities for energy, with social, environmental and other priorities — a complex task.

"In developing these resources the country will have to manage costs and keep a positive scope on our productivity curve if we wish to provide serious economic competition to other countries."

# Learning about the tar sands

Educational kits, designed to enable students to explore the mysteries of Alberta's tar sands and to learn something of the Syncrude project, are a form of public relations that is working out very well, according to Tudor Williams, coordinator of Educational Services for Syncrude Canada Ltd.

"It presents a vehicle of providing information and better understanding to the general public."

The Educational Services division was created as a result of a flood of requests for information on the project that was not readily available anywhere else.

"University students in the economics field, social and science majors and engineering students were asking for data for theses and term papers. Interest was just getting generally high.

Consequently Williams, a former chemistry teacher with nine years' experience, was given the task of finding additional help and developing and compiling the resource material.

The first educational package produced was a kit designed for secondary level science classes in which the students are encouraged to participate in laboratory experiments by actively working with the tar sand, removing the bitumen and studying the components.

The history and geography of Alberta tar sand deposits are examined as well as their importance to Canada and the world.

Labelled "Oil from the Tar Sands", this kit sells for approximately $20 and includes teachers' notes, tar sand samples, color slides and graphic illustrations for overhead projector use. All material has been classroom tested and, as a result, some slight modifications have been made in the light of practical experience.

Another package has been assembled for the grade two-to-five group, dealing with the history of Fort McMurray, the differences in life styles from place to place and the impact of the oil sands development on both the environment and the people.

An extensive social studies project is underway, as is another package dealing with the environmental and conservation points of view.

"Our educational services have to stand on their own merits," says Williams. "An important goal we are aiming at is the up-dating and Canadianizing learning in our schools. For the most part our programs have been more enthusiastically received than we ever anticipated."

Although the units being developed are basically intended for Alberta use, keen interest in the project is being evinced in both Ontario and British Columbia.

"We have been attempting to locate a similar project for comparison purposes but, since it is a relatively new innovation, we were able to find only one which bore any resemblance—and that one was in Britain.

"There is a program currently being developed by the Society of the Environment and Energy Development Studies (SEEDS) which is following somewhat the same pattern as ours."

The Educational Services division has also become involved in school science fairs held in Edmonton, Calgary, Medicine Hat, Lethbridge and the Peace River Zone.

Syncrude Environmental Awareness awards are given for the best presentations and the winners are taken up to the Mildred Lake plant.

"In essence it is a two-day workshop on the environmental aspects and filled with enrichment activities," says Williams. "Fort McMurray is going to have a science fair this year."

*A high school class studies a miniaturized separation process*

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*The 80 cubic yard buckets for the draglines*

*The conveyors from the mine where they join the extraction plant feed system, also showing the control tower*

## Ian Efford — continued

"The incentive to reduce unnecessary waste is quite striking. If we have an average growth rate in energy of two per cent between now and 1990 instead of a four per cent rate the difference is equivalent to 2 x 10 $^{15}$ BTU. In primary energy terms this figure is equivalent to the output of six Syncrude plants, plus 80 per cent of the expected annual Canadian output of the MacKenzie Valley Pipeline, plus 15 Pickering-size nuclear power plants, plus 10 million tons of bituminous coal. An amount worth saving!"

### Adapting to change

As the movement grows towards greater energy efficiency and conservation becomes even more of a household word than it is today, the various segments of our economy are going to have to reassess their situation to adapt to the change. The business community is undoubtedly conscious of the fact that declining energy growth rates, restructuring of utility rates, moving towards recycling, etc. will have an affect on their traditional role.

The growth rate in the commercial sector has been almost twice the national average. This sector has seen exceptional growth for the recent period which has accounted for much of this, but I believe we all realize that this rate cannot continue in the future. We have derived from our analysis a growth rate of two per cent per year which can be reached by 1990. To reach that, however, the commercial sector cannot continue to grow at more than 10 per cent.

This may appear that we are recommending the cutting out of many goods and services, but such is not the case. Significant energy savings can be achieved in existing commercial building without major capital expense. The reduction results from tuning of building systems and from switching off energy consuming portions of the systems when they are not required. An example would be closing off the ventilation system during unoccupied hours. Such saving should be of the order of 50 per cent for an average office complex.

New buildings designed to minimize energy consumption have been built and are now in the early stages of operation. The new Ontario Hydro building in Toronto is expected to consume no more than 16 kwh per square foot per year and this compares to B.C. Hydro survey of office buildings in Vancouver which averaged 64 kwh per square foot. For these new buildings, design costs are somewhat higher, but the reduction in capital cost of the heating, ventilation, air conditioning and lighting systems more than offsets this extra cost.

### Building Code change

The federal government has drafted an entirely new energy section for the National Building Code. It will be made public in June and all provinces have indicated their plans to adopt the new code. Eventually we will be moving beyond a prescription building code to a performance code. This is more flexible and will designate energy efficiency standards for all buildings. It will be up to the design engineers and architects to determine the most efficient and least expensive ways of meeting these standards.

Our studies are also examining ways of making building owners more concious of energy use. A limit to the write-off allowed for energy and a restriction on the pass-through costs of energy are two areas that look promising.

### Long-term viability

You will also appreciate that, because our goods in Canada have been so energy-intensive, our international competitiveness is being seriously eroded. If we do not begin to act quickly and decisively then other countries, which are making strides to become more energy-efficient, will pass us and remain ahead. For the long-term viability of our economy we cannot afford to be wasteful.

I believe there are some trends occuring that you will have to contend with in your business community.

The first is appliance labelling. Appliance usage of electricity is rarely known with any degree of accuracy by consumers. In an attempt to improve the situation, an appliance energy labelling program is being developed by the federal government. It is hoped that these labels, supported by a comprehensive publicity program, will result in appliance purchase decisions that take into account all capital and operating costs. The government is expecting that by the end of this year or early 1978 all of the major household appliances will be tested under standard test procedures. These test results will be publicized widely so that the consumers will see the rank of the various appliances in terms of energy consumption. A similar program is in progress for furnaces.

The second is packaging. I believe there is a growing trend away from today's use of packing. Often packages are thrown away and with the increasing strains on solid waste management and on the materials used to be simply thrown away, more care will have to go into packaging.

The third is recyclable containers. Tied in with packaging is the move towards recyclable containers and more durable products. In the beverage industry there has been considerable success, for both bottles and boxes, and this should be expanded into other areas. The move, however, will mean more jobs in areas of re-packing, cleaning and distribution.

The fourth is labour. With increased energy costs, there will be a trend towards more labour intensive products. As well, as we move towards more recycling, there will be more labour involved.

The next is renewables. The federal government and many provinces are giving increasing attention to renewable resources. Although renewable energy sources are not expected to have a considerable impact in the short or medium term, they will begin to expand their impact.

### All sectors of economy

The federal energy conservation program covers all sectors of the economy — buildings, industry, consumer products, transportation, etc. — and gives an indication of the direction in which we are moving.

Resources are vital to our country and our economy. We cannot afford to squander nickel or coal any more than we can afford to squander our forests and waterways. They are all interconnected and they all point down to the way we see our economy and our society growing and developing.

Energy conservation is most immediate because of the supply problems over the past few years and because it is far less expensive than producing more energy. Our society cannot function without energy but we need it to be as productive and efficient as possible.

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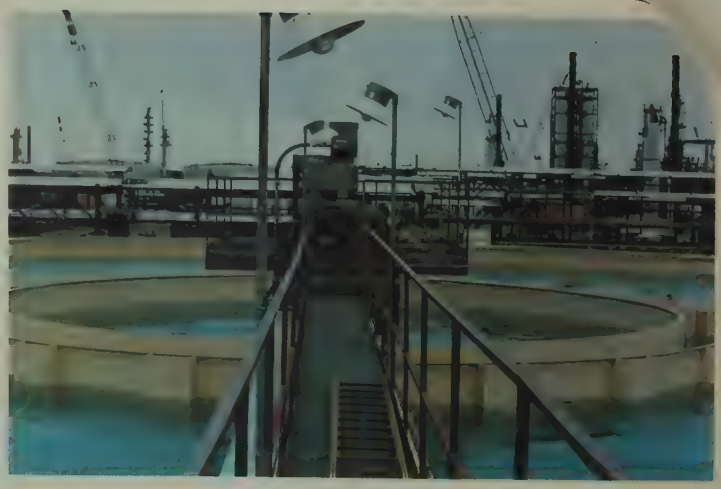
*The utility plant switchyard under construction*



*One of the water treatment tanks*

# "Life is fragile: handle with care"

## Conservation department conserves everything

Anything to do with the conservation of life, limb, health, safety, property or equipment, land or vegetation — that is the concern of Dick Hunt, manager, and the people of the Conservation Department of Syncrude at Mildred Lake.

In fact, that concern is conservation in its broadest sense, from fire training and protection to medical services and from environmental co-ordination to loss of time in the plant.

Hunt calls it "totally a loss control concept." He goes on, "There is the question of the loss of time through injuries and loss of money through damage, theft or loss of equipment; there are environmental concerns in general, and on the land reclamation side of our activities we are attempting, in close collaboration with the company's environmental scientists and the Environment department to turn the oil sands back to a condition similar to what they were before we came — in some cases a little better. We started last year on the practical side of land reclamation and already a very great deal has been done, notably in revegetating, seeding and fertilizing."

In the area of fire protection a fire hall, equipped with modern trucks, rescue apparatus, all the necessary tools of firefighting, together with foam facilities, was part of the fire department which comprised a fire co-ordinator who had had 25 to 30 years' industrial firefighting experience, and three technicians. They were responsible for keeping the equipment in good working order, but even more importantly they were also responsible for training firefighting personnel — firefighting crews drawn from each shift.

"We have to depend on people on the site, and we are currently building a fire training ground, but already 34 people have been to the Texas A. & M. fire school which is recognized as being the best school of its kind in the world."

In addition to firefighting apparatus at the fire hall there were, around the site, between 3,000 and 4,000 portable fire extinguishers ranging in size between 20 lbs. and 350 lbs., and all these, together with the signal systems, had to be maintained.

So far as safety measures were concerned, supervisors were responsible for safety measures and precautions within the areas of their own jurisdiction, and individuals have the responsibility to work in such a manner as to safeguard themselves, fellow employees and the company's assets. The safety department itself was a resource group responsible for preparing safety procedures and programs.

### First Aid courses

St. John Ambulance First Aid courses were a prominent feature of emergency training. Everybody was currently undergoing a 16-hour course in First Aid, and 200 to 300 certificates had already been presented. Every week a course was attended by 20 to 25 people dependant upon the hiring rate.

"First Aid courses have an additional benefit," Hunt goes on. "They act as a stimulus to the safety program and it has been shown that where such courses have been held they make people much more conscious of the need for safety procedures and make them much more careful. They, the courses, seem to assist in the reducing of injury incidence."

In the maintenance of security the company was gradually taking over from Bechtel as construction finished area by area and during 1978 this changeover would become more

*(continued on Page 57a)*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# Automation maximized

## Control from three separate centres

*Controlroom centre of the upgrading operation*

Maximum use of automation and instrumentation, basically electronic and miniaturized, has been made at the Syncrude plant.

Computerization is also a feature of many operations but only in data logging where better use can be made of the operators' time — though a special technical control group is charged with responsibility for studying future conversions to computerization.

The operation of the whole complex will be controlled from three separate centres — mining, extraction and froth treatment, and upgrading and utilities.

The mining operations centre will have primarily monitoring and metering type instrumentation. In the extraction and the upgrading and utilities operations centres, control will be by automatic units on an instrument panel.

Electronic data acquisition equipment will be used to gather data automatically and distribute process information to the control centre, and from there to two satellite information centres in the major unit areas.

For the most part, the processing of data will then be done by an off-line computer.

Particular attention has had to be paid to the design and construction of instruments located outdoors so that they will continue to function reliably at temperatures down to -50 degrees C.

## Life fragile — continued

and more complete. A co-ordinator controlled security guards, together with roving patrols of radio-equipped trucks. "It is impossible to fence in such a vast area; we must rely on roving patrols." The majority of the security people were, whenever necessary, given a very good training course and they were being encouraged to move, with their families, to Fort McMurray.

On broad lines the objective of the department was to co-ordinate a total loss control program, recording all cases of injury, fire, theft ("we find the great majority of people are honest"), damage to equipment and so on, and at present they were working on the development of a computerized program that would produce figures whenever they were called for, whether by managers in the plant who wanted to check on their records or on high risk periods, or by anyone else interested in maintaining standards. "We consider all incidents in terms of a loss control program and all of them will go into the computer so that we can get a complete picture at any time.

"We do not report people or apprehend them. That is not part of our job. Our objective is to try to correct any situation that might arise."

Emergencies were looked after by an emergency group and manning on a one-man-a-shift basis was ensured right around the clock. This was backed up by a comprehensive reporting system that, by means of a "red telephone" procedure, alerted all parts of the plant. There was a complete tie-in with the communications centre and it was possible to contact immediately all those who had to respond quickly to a complete call-out in cases of emergency and who were all fully knowledgeable in the use of rescue equipment.

In land reclamation where "we become the farmers", the department moved in as each project was completed and revegetated the area. Reclamation of 150 acres at Beaver Creek where extensive diversion operations had disturbed the land was an example of this.

"There's a lot at stake here," said project fire marshal Ken Barraclough. "In each bunkhouse there are 42 people, and a fire at night, if not brought quickly under control and extinguished, becomes a major hazard to life as well as to property."

Barraclough does his job from a centrally-located firehall.

Each bunkhouse is equipped with heat and smoke detectors, fire alarms, extinguishers and hose. And they are grouped in blocks of six, with a 20-foot firebreak between each bunkhouse, and a 120-foot firebreak between each block of six.

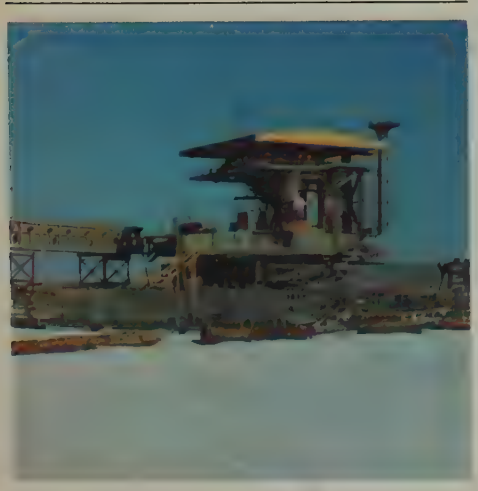
There was very close collaboration with the company's environmental people, and currently the department had underway a comprehensive tree study.

In the medical department a doctor was being recruited. At the moment a doctor visited the site from Fort McMurray three or four days a week. There was already a company hygienist responsible for keeping an eye on the hygiene of working conditions — such matters as the working environment generally and the conditions of dust, noise, chemicals and light.

The medical staff comprised two full-time registered nurses and one part-time nurse who served as relief, and these were the people also responsible for First Aid training.

The department was currently getting together a health and safety booklet for general distribution.

"The real problem," says Hunt, "is to get qualified people — and retain them. We need the right people." And, he concludes, "Our guiding principle might well read, 'Life is fragile; handle with care.'"



*The control house of the bucketwheel reclaimer which transfers the mined tar sand on to the conveyor system*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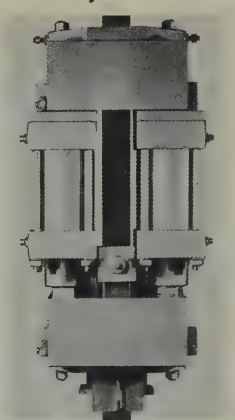

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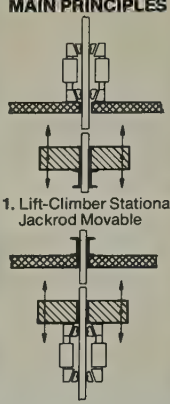

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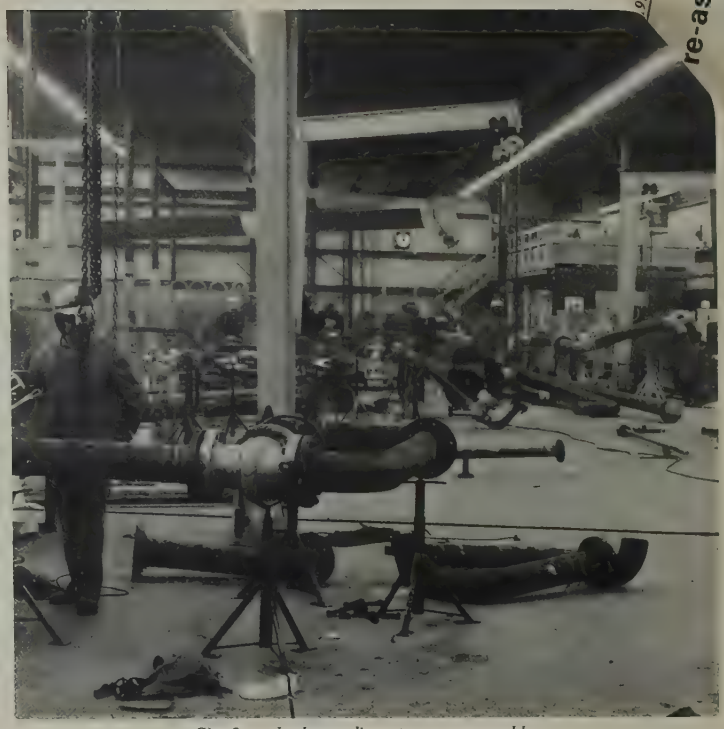
*Pressure vessels being insulated at Edmonton*



*Site 2 — the large diameter pre-assembly*

# Future application of pre-assembly

## "We have barely skimmed the surface of what is possible"

There's no real cut-off in the application of modularization or pre-assembly, except for the problems and limitations set by logistics. And, of course, it has to be cost saving, since that is the basic reason for doing it in the first place," Robert F. Reinhard told Construction Alberta News in discussing the future direction of the pre-assembly concept.

Reinhard, who is vice-president, Canadian Bechtel Limited, and project manager of the Mildred Lake construction operation, added that the successes and mistakes of Canadian Bechtel's experience with pre-assembly on the Mildred Lake project are being constantly evaluated.

"We've barely skimmed the surface of what is possible," he said. "But certain aspects are self-evident."

The idea of pre-assembling components or building modules ready for installation into a jobsite structure is, first, restricted by what can be reasonably handled on site.

"If, for example, you're building a plant in the barren wastes, and send in modules that are too large for the on site crews to handle, then the concept loses its value," said Reinhard.

"Massive modularization also has a high risk tag related to the consequences of damage or loss. Moderate-sized modules generally have greater flexibility and a lower risk factor. Obversely, pre-assembled modules are only of economic benefit if they consume a lot of production manhours."

The application of pre-assembly has to be governed by the modes of transport running into the jobsite. "If there is only a railroad, your pre-assembly planning must take into account the fact that a railroad won't take wide loads as a highway can.

"In the case of Mildred Lake, where the highway generally is 28 feet in width, loads over 20 feet wide were trucked up which just could not have gone by rail.

"Although a railroad will usually carry heavier loads than a highway, in pre-assembly you're dealing with volume not weight," added Reinhard. "For example, most of the pre-assembled modules sent north from our pre-assembly sites at Edmonton Field Operations (EFO) — complete units ready to be dropped into the overall plant structure—were open, not solid structures. Weight was not the critical factor. Size was. Shape was."

Scheduling and the punctual delivery of materials and components to the pre-assembly facility were also vital, said Reinhard.

A case in point, if not in pre-assembly but in principle, was the shipping of four Italian-made sulphur extraction units, or go-finer reactors. These had to arrive in Edmonton for hauling up the Northern Alberta Railways track in January or February, when the muskeg was frozen hard enough to carry the weight.

### Costly problem

"Apply this to a project under construction in the far north, where you are shipping modules by barge. Let's say the modules are delayed in completion due to slow component deliveries. The barge, in turn, is delayed in sailing and can't get north into the jobsite because ice has formed. You've got a costly problem on your hands."

In other areas of the world it might be such inclemencies as monsoons or hurricanes that have to be taken into account.

"Early planning becomes the key factor. And the earlier the better, so that feasibilities can be studied, and operations avoided which cannot possibly succeed.

"Cost," repeated Reinhard, "is the sole factor.

"Personally, I believe there is a large place for the pre-assembly concept in future jobs in remote areas, where there may be no pool of skilled labour, maybe no labour at all.

"The essence of the concept is that materials and components are pre-assembled under controlled working conditions, frequently not possible at a jobsite; that the high costs of accommodation, food and recreation at a remote site are reduced; that the pre-assembly facility is located in a centre which has a pool of skilled labour on which to draw.

"It eliminates many jobsites material shortages which can delay planned construction schedules, or throw them out of sequence.

"By the same token, the concept can equally well be applied anywhere, even in developed areas. Work is almost always better performed under controlled conditions. At a jobsite, these are either difficult or expensive to achieve, whether you're talking of Mildred Lake or the outskirts of Edmonton.

"Obviously, it's easier and more efficient for a man to fit a valve to a pipe that is lying on the ground or on a cradle in a workshop, with all trade amenities to hand, than, say, for the same man to fit the same valve to the same pipe when he's working 30 feet up in the air on a scaffold, outdoors, and the weather is bad.

"In addition, proper supervision and safety measures can be more effectively applied."

Reinhard believes that the pre-assembly concept could have a significant impact on construction philosophy and techniques in general.

"'Build everything on site,' has always been the theory and the practice. But we are learning that this is not necessarily the most efficient way to do things, or the most economical."

### Planning is the key

Out in the field at Mildred Lake, Don J. Gunther, upgrading site manager, and recipient of a high percentage of the pre-assembled materials and

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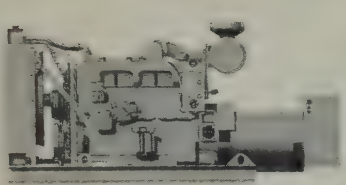

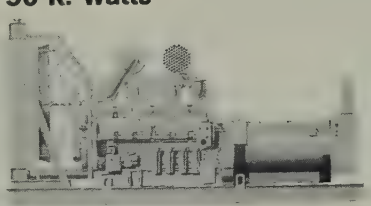

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## Pre-assembly — continued

units sent north from EFO, stressed that planning is the key to the injection of pre-assembly to a project, but that constant communications during the job itself are essential.

"Priorities must be endlessly kept under review," he told Construction Alberta News, "and liaison maintained closely between jobsite and pre-assembly facility. We hold regular meetings with the people at EFO to ensure that, above all, construction goals are being met.

"In addition, a co-ordinator shuttles back and forth between the jobsite and Edmonton, checking our construction priority lists and schedules against pre-assembly production and capability. It's as important to know what EFO cannot do as it is to know what it can do.

"For example, you can't just decide that you need a double order of something and expect the request to be instantaneously met.

"Planning and scheduling never cease, and because of this, the system does require far more paperwork to control. Lists and schedules have to be kept in order and ongoing, increasing the cost of non-manual employee hours.

"The system is different, and we are just starting to learn how to make the best use of it. One of our thrusts here has been to try as hard as we can to communicate to employees on the site what we are trying to do with pre-assembly. We've frequently sent employees to Edmonton to visit the EFO sites to understand what they are all about, and where the EFO facilities fit into the overall project."

How far could the system have gone at Mildred Lake, at the upgrading site? "This section of the plant will employ 16.2 million manhours when it is complete," said Gunther. "Of that total, 1.7 million manhours have come out of EFO. My estimate is that we might have gone as high as 2 million manhours."

But then, by general admittance, and due to a variety of unforeseen circumstances, the pre-assembly idea was not built into the total project at an early enough stage. The extent of pre-assembly was developed during the course of construction, without the luxury of having the concept used as a basis of engineering design.

"We had to adapt as we went along," said Gunther.

A case in point at Mildred Lake related to underground electrical conduits. Initially, the requirement was for EFO to pre-assemble only the configurations. These would be shipped to the jobsite, laid in trenches, and have concrete poured around them.

However, a study made curing construction showed that pre-fabrication of complete electrical duct-banks, clad in concrete, was possible at EFO and could be sent up ready for installation. The potential saving was $1.5 million.

Without in any way criticizing the procedure or its objective, but using it as an example of the need for earlier planning in general, Gunther explained that the delivery of the completed ductbanks, in their heavy concrete casings, posed an unscheduled handling problem at Mildred Lake.

Men carrying pipe, laying it in a trench, and pouring concrete around it —as originally planned — is one thing. Laying concrete-clad ductbanks with cranes is another.

"Pre-assembly in future projects has to be built into the very earliest planning so that the right equipment is at the right place at the right time."

### Rigid control at jobsite

Rigid control must be applied at the jobsite on the progress of a structure, to ensure that pre-assembled material can be fitted in correctly. "As construction of a structure moves ahead," said Gunther, "you have to make sure that appropriate spaces are left for the pre-assemblies or modules, and that when they do arrive, there's sufficient elbow room for the tradesmen to make the necessary installation or hook-up. It would be very easy, by analogy, to paint yourself into a corner.

"In future, we may find ourselves having to develop new skills to handle projects in which pre-assembly is a design factor. Tradesmen at a jobsite may be putting more emphasis on skills associated with the installation and hook-up of modules or pre-assembled components than on building a structure piece by piece, which has been the accepted concept in construction in the past."

As the man in the field, Gunther also recognizes the contingency value of pre-assembly. "If, for example, we know that we are going to have a delay in some work area on site due to materials shortage, maybe even a labour shortage, we can use EFO to help fill in the gaps."

In Edmonton, EFO manager Del Zambon believes that, although pre-assembly is not the end-all to problems facing the construction industry, the Syncrude Canada pre-assembly operation represents only one of several avenues available to accomplish objectives.

"Tradesmen work in what is, in effect, a normal manufacturing facility. In many cases, of which our production of 1,400 instrument assemblies was one, it is production line work, which is just not possible on a jobsite.

"At EFO, much of the work and materials were brought to the tradesmen, just as they would be in a controlled factory environment. On a jobsite, the tradesman usually has to go and fetch his materials from a storeroom, carry them back to his work location. This, more often than not, is outdoors where his work can be affected by weather or by the sheer physical strictures of, say, working on his back, or on a high scaffold.

"We have just skimmed the surface," said Zambon. "If projects are engineered and procured with pre-assembly as a basic tenet, many additional manhours can profitably be shifted to a pre-assembly facility from a jobsite.

"Savings accrue from two major areas: those achieved by transferring manhours from a remote jobsite which requires premium labour costs, camp facilities, and operation costs; and savings from the benefits of applying manufacturing techniques to the construction industry."

The expertise and experience developed by Canadian Bechtel on the Syncrude Canada project are already part of Canadian construction technology. And the application of pre-assembly only to remote areas is not an absolute.

Mildred Lake's muskeg-girt environment, 300 miles north of Edmonton, adds drama to the scenario. But the basic principles of pre-assembly have been established beyond the parameters drawn for them.

Undoubtedly, pre-assembly will, in time, contribute significantly to the major projects presaged for our northern expanses.

*Pre-assembly of instruments at site 3 illustrates assembly-line technique*


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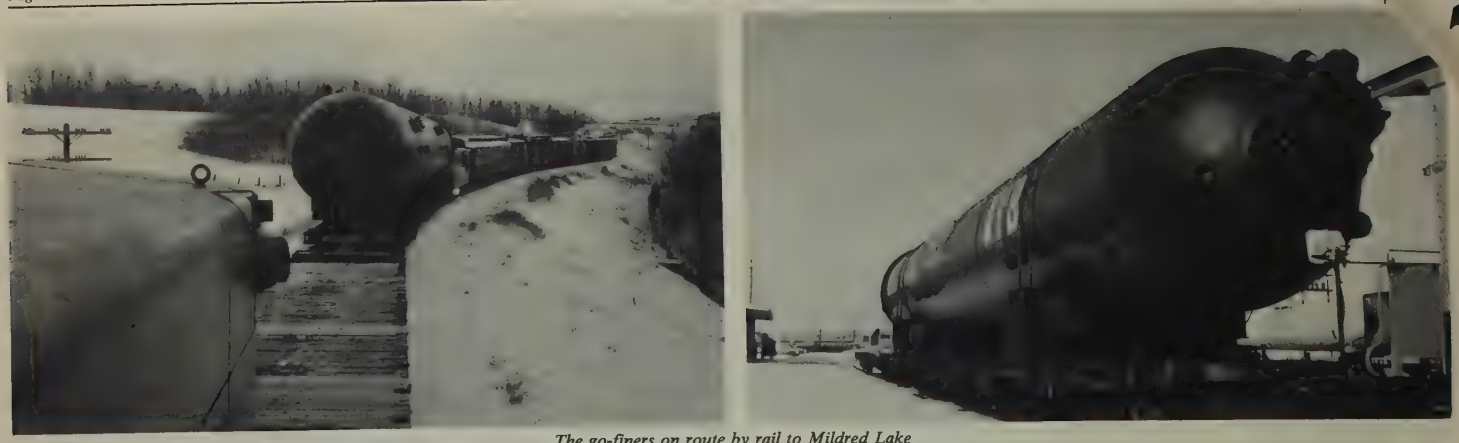

*The go-finers on route by rail to Mildred Lake*

# From Italy with—success

## How the go-finers came to Syncrude

There are many instances of unusual achievement in the story of the construction of Syncrude Canada's Mildred Lake plant. Many relate to the mammoth task of transporting materials, equipment, stores, plant units, to the jobsite 300 miles north of Edmonton.

Of these, the movement of sulphur extraction units, called go-finer reactors, from their Italian fabricator to the Alberta northland is just one. However, in many ways, it exemplifies the intricate planning and ingenuity involved in the recovery of Athabasca's oil.

There were four of them. Delivery, undamaged, was critical to the completion of the Syncrude plant. Serious delay or damage could postpone that completion for a year or more.

Each weighed 774,000 lbs., with a length of 108 feet, a diameter of 12 feet. They came by ship from Italy to Saint John, N.B., then by CP Rail to the Northern Alberta Railways' (NAR) Dunvegan Yards in Edmonton.

From here, they travelled by NAR tracks to Waterways (Fort McMurray), and finally by road up to Mildred Lake.

It sounds simple and straightforward enough. But there had to be taken into account the special railcars that are needed, the checking of clearances along the track and on the road, the methods of transferring the loads from ship to train, from train to train, from train to truck.

Then there was the worry about timing. In Alberta, the best months for moving excessively heavy loads, especially across the muskeg north of Edmonton, are January and February. The ground is frozen hard, and transportation hazards are at their lowest.

However, for the 300-mile run over the NAR track, it could be said that January and February were the only months.

The NAR line from Edmonton to Waterways was never built for such loads. Some sections of its track are of light 60 lbs. rail (i.e. one yard of rail weighs 60 lbs., against the 100 lbs. or 130 lbs. rail used for continental main lines).

The go-finers had to be carried by NAR before any thaw set in.

In general terms, two considerations have to be borne in mind to avoid damage or accident when carrying excessively heavy loads by road or rail — the weight exerted on individual axles, and the centre of gravity of the gross load.

The more axles, the more wheels per axle, the less weight is imposed on any one of them. The lower the centre of gravity, the more stable is the load being carried.

In road vehicles, more than two wheels can support any one axle. Not so with a railcar. There can only be two wheels per axle.

With this in mind, during the initial planning of the movement of the four go-finers, it was realized that to carry each one across the NAR line safely, sets of two 12-axle flatcars would be required. They would also be preferable on the CP haul from Saint John. But the company's heavier mainline steel made the use of 8-axle flatcars possible.

The only 12-axle cars right for the job were located in the U.S. and, although the move was planned two years before it took place, only two were available for leasing during the critical months of January and February. They came from the St. Louis Southwestern Railway Co.

Timing and scheduling thus became an acute priority. Over a period of many months, executives at Canadian Bechtel, the managing contractor, maintained a close watch on the progress of construction in Italy, to ensure that the go-finers arrived at the NAR's Dunvegan Yards in time to be hauled north while the muskeg was frozen hard.

The scheduling was further complicated by the correct insistence by Canadian Bechtel that the go-finers not be shipped across the Atlantic on one freighter They were to travel in pairs, on two ships.

In the event, for the Atlantic crossing, the go-finers were shipped in pairs, the ship making two crossings between Venice and Saint John. This ship, of German registry, has its own off-loading facilities, for Saint John, although a major port, does not have the necessary crane capactiy.

CP Rail had, however, handled larger individual pieces in the past, and its track could carry the load, if due care was taken.

But "due care", in the hauling of 774,000 lbs units, has its own terms of reference.

For each pair of go-finers, a special train was made up in which, to distribute the weight as much as possible, and prevent especially excessive stress on bridges, piggy-back flatcars were used as spacers between the locomotive and the go-finers, and between the go-finers themselves.

In the event, the Saint John-Edmonton leg took 11 days, with the special trains running only in daylight hours until they reached the western limits of Northern Ontario's rough terrain.

The maximum speed was 20 miles per hour, and on more than one occasion speed was reduced to walking pace. According to CP Rail, there are 62 tunnels, bridges and rock cuts where the trains' crews had to exercise special caution. As the original instruction plan decreed: "Do not stop train on curves or bridges."

At NAR's Dunvegan Yards in Edmonton, the go-finers had to be moved one at a time from the CP trains to the 12-axle cars leased from St. Louis Southwestern.

But the Yards had to cranes large enough to lift the pieces. The job was done by using parallel tracks. A go-finer on its CP cars was moved alongside the set of two 12-axle flatcars. A wood and steel girder frame was then built between the two, and a go-finer was winched across. In each case, said NAR chief engineer Lee Halasa, the transfer took close to two days.

On NAR's track across the muskeg, only one go-finer was carried at a time. A special train was made up for the job.

"We sent two crews," said NAR traffic manager A.J. Dove. "With the concurrence of the men, we threw out normal working conditions. They set their own hours."

The special train comprised a locomotive, followed by an empty spacer flatcar and the go-finer on

*(continued on Page 61a)*

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# Natural gas relative to bitumen projects

The Energy Resources Conservation Board has released a report on the application of the Saskatchewan Power Corporation for a permit authorizing the removal of 197.1 billion cubic feet of gas over a term of some 15½ years beginning next month from the east central Alberta areas of Ashmont-St. Lina, Redsprings, Lindbergh, St. Edouard, Frog Lake, Saddle Lake, and West Saddle Lake.

In appraising the application, the board has reviewed the reserves available to the applicant, the deliverability of these reserves and the Alberta gas surplus if a permit were to be granted. In addition the board has considered the availability of gas associated with curde bitumen in the areas of application and has examined gas requirements for experimental crude bitumen recovery projects.

From its review of the reserves available to the applicant in the areas of application the board finds that 126 Bcf of gas are available for removal from the province over the proposed term. The granting of a removal permit for such a volume would result in present and overall gas surpluses of 10.4 trillion cubic feet and 8.6 Tcf respectively. The available for contracting surplus would be 2.6 Tcf.

Therefore the board finds that the 126 Bcf of gas is surplus to the present and future needs of Albertans and that the granting of a gas removal permit would be in the public interest.

In the board's opinion the prior production of gas in association with crude bitumen would, in the worst case, cause only a short-term and minor detrimental effect on the recovery of crude bitumen; an effect that could be offset during a later phase of the thermal recovery technique.

Consequently, the board can find no basis for disallowing the production of the associated gas and in accordance with this finding has recently granted an application, initiated by Kissinger Petroleums Ltd. on behalf of the other operators, for production of this gas.

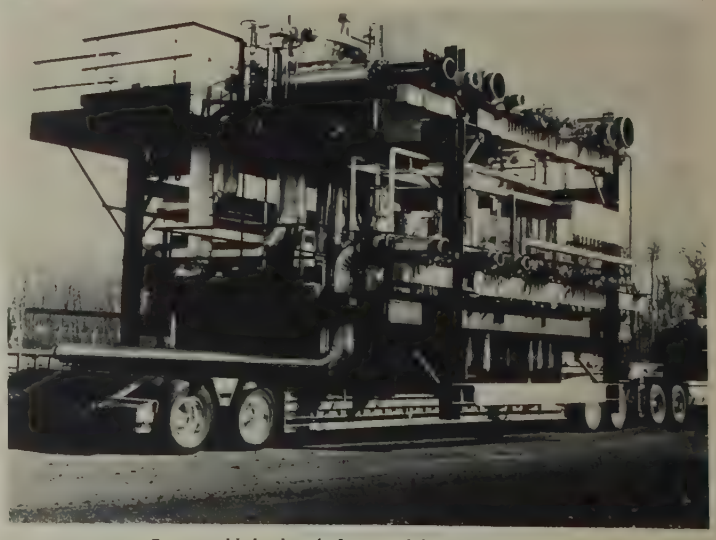
### In situ projects

The board is of the opinion that experimental in situ projects will form an integral part of the development of the oil sands potential of the province and, therefore, the gas requirements for these schemes should be included as a provincial requirement.

However, since the board believes it inappropriate to designate a particular end use for gas under the control of the applicant in the areas of application, the gas for the experimental projects need not be supplied by reserves in the areas of the deposits.

The board has included in the report, for the information and use of the government in its consideration of the application, particulars respecting three matters raised at the hearing by the interveners. These matters include the contention that the applicant's gas requirements can be met from sources indigenous to Saskatchewan, the contention that the granting of the application would provide tax and royalty benefits to the province of Saskatchewan and the contention that a reduction in field prices for gas in Alberta could result through the reduced utilization of existing transmission facilities to eastern Canada.

Based on its findings, the board is prepared to grant a permit to Saskatchewan Power Corporation, but would include in it maximum daily and annual removal limitations of 37 million cubic feet and 11 Bcf respectively.



*Pre-assembled valve platform module in transit to jobsite*

## From Italy — continued

its two 12-axle cars. Next came a caboose, crew cars for sleeping, eating, and off-duty, a kitchen car (with a cook on board), another caboose and a business car for the railroad executives.

"There was to be no stopping," said Halasa. "The men in the two crews would be living on the train for the 24 hours or so of the trip. And a constant watch had to be maintained on the go-finer. For the night hours, we rigged spotlights on the locomotive and the leading caboose, both focussed on the go-finer."

For the entire trip, crewmen and either Halasa or Ken Perry, NAR's late general manager, were on watch, checking by eye for the slightest sign of oscillation by the go-finer, and by instinct on the state of the muskeg.

The total load carried on the 24 axles of the 12-axle flatcars was 1,110,600 lbs. Of this, 774,000 lbs. was represented by the weight of the go-finer being carried. Tare weight of the two flatcars was 326,000 lbs. Weight of the bolsters used to hold the go-finer firmly in position was 40,000 lbs.

Weight per axle: 46,275 lbs.

"We started at five miles per hour," said Halasa, "and built up speed slowly to a point where we felt oscillation might become a factor. If this seemed likely, we reduced speed. At no point did we exceed 14 miles per hour, and most of the 300 miles was run at 10 miles per hour or less."

At Waterways, Canadian Bechtel had sent down special cranes and road vehicles — with eight wheels to the axle — for the last lap, up the hard gravel highway to Mildred Lake.

That trip from Dunvegan Yards north was run four times, once for each go-finer, and all before the end of February.

The deadline had been met. For Canadian Bechtel, CP Rail, NAR, and others involved, it could be said that "the impossible has taken a little longer" — and it had been achieved.

# Statistically speaking

Statistics may be dull, but they are informative. In the case of Canadian Bechtel's Edmonton Field Operations (EFO) and pre-assembly work they tell their own success story.

It is now estimated that by the time EFO closes down, its work complete, the sites will have shipped to the Mildred Lake jobsite:-

1,100,000 linear feet of pipe, 500,000 linear feet of underground electrical ductbanks, 310,000 square feet of fireproofed structural steel, 278,000 square feet of formwork, 105,000 square feet of temporary buildings;

8,500 cubic yards of precast concrete foundations, 2,200 tons of rebar caissons, 1,400 instrument assemblies;

400 pumps and driver assemblies, 60 electric heat tracing racks, 53 modules, 16 electric control houses, and five pumphouses.

In addition, 36,300 square feet of refractory work will have been completed, 297,000 square feet of equipment and ductwork will have been insulated, as well as 239,000 linear feet of pipe.

# New language of pre-assembly

The evolution of the concept of pre-assembly of piping and modules has led to the use of a whole new set of definitions by Canadian Bechtel's engineering staff.

As explained by a senior engineer, it goes like this:

If you join pipe, fittings, and flanges, that's traditional fabrication.

If that pipe is bolted or welded to other pipe spools (say, a control valve manifold), that is pre-assembly.

If that control valve manifold is mounted on a process vessel, that's an assembly.

If the vessel is mounted with an exchanger, complete with associated structural steel, platforms, electrical and other utilities, as part of an overhead exchanger structure, that's a module.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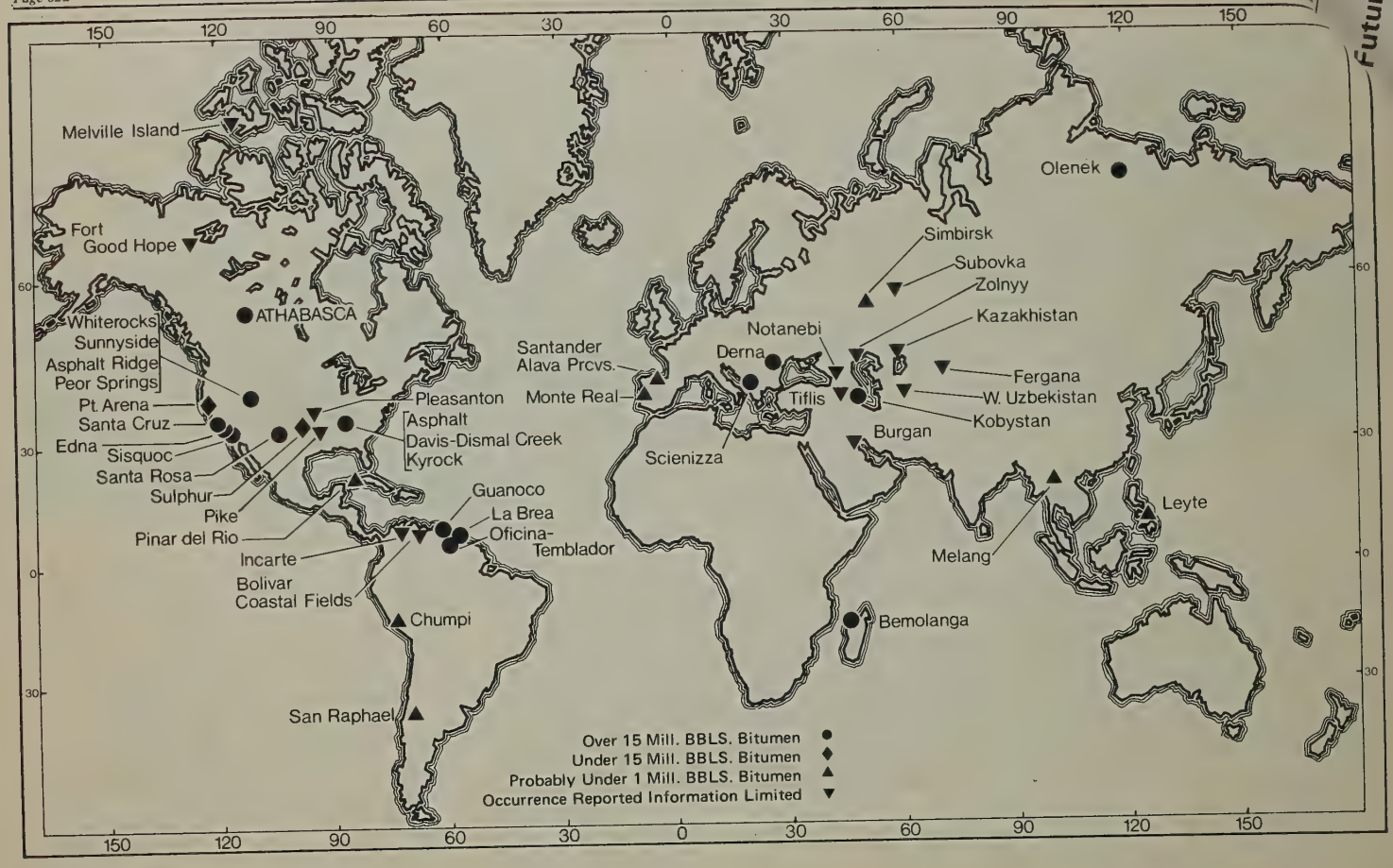



# What of the future?

## Tar sand areas of the world are now in focus

Without committing themselves the provincial government and the federal government, together with their oil-related agencies, seem to be pretty confident that the Syncrude operation is not the last of the tar sand shallow mining projects.

Whatever else Syncrude has done — and it has done plenty more — it has brought the tar sands potential sharply into focus. GCOS may have done this in a limited way already, but people's minds are now becoming attuned to terms of production on scales that, except in the minds of a few far-sighted and imaginative individuals, were only fleeting dreams a few short years ago.

Needs must when the devil drives, and in this year of grace it is all too evident that, whatever Canada's energy resources may be there is going to be a yawning gap — a gap that can be filled only by expensive importing of oil — between demand and supply sometime during the next decade. For the plain fact is that Syncrude will already be too late when it comes on stream — Frank Spragins, Syncrude's chairman, says it will be 15 years too late — to bridge that gap.

So when it comes to decisions on other Syncrude plants one wonders what is holding everybody back.

GCOS has proved that the technology of the pilot plant has successfully passed the test of practical application. Perhaps hesitation therefore derives from the sheer mammoth scale of the quipment that Syncrude is bringing into play.

This could be valid.

The mining and processing procedures, in some cases modifying methods adopted by GCOS, have long since passed their pilot plant hurdles. In theory they should work. But there is a lot of unpredictability hovering around massive machinery that, every hour, will be expected to handle enough material to fill a football field to a depth of eight feet — and some of this machinery, the biggest of all, expected to 'walk' around the mine site as well!

But the conclusion must be that, if everything does what it is designed to do and Syncrude, coming on stream next year with no more headaches than can reasonably be expected, fulfills at least most expectations, Alberta may well look forward to another Syncrude-type plant — perhaps three more — in the fairly near future. That, at any rate, seems to be the general feeling among people in the know — hedged, of course, by some faceless reservations.

One thing: all other things being equal, future plants of the Syncrude genus are unlikely to be held up by money questions — though the longer the delay the higher the costs will be. The experience of the province of Ontario in

*(continued on Page 63a)*

## Future — continued

investing $100 million in Syncrude — considered at the time by the majority of Ontarians to be reckless and disloyal spending — and already getting very much more in return in terms of manufacturing and services, and therefore employment, may well prompt other provinces to make sure of a piece of the action. Nothing succeeds like success, and the hopes for Syncrude run high.

### In situ potential

But there is another aspect to all this, too. And that is the possible recovery of oil from the deep tar sands deposits which in volume constitute 80 per cent of the whole tar sand potential.

The tar sands area of northern Alberta covers some 19,000 square miles and contains ultimate reserves of more than 900 billion barrels of oil in four major deposits. From the Athabasca Tar Sands alone (the world's largest known deposit), 26.5 billion barrels of synthetic crude can be produced by present methods from proved, mineable oil sands. Future improvements in mining and processing techniques may raise this figure to over 80 billion barrels.

But if the tar sands at depths too great to be reached by surface mining methods can still be exploited, an additional 250 billion barrels will be recoverable. And deep 'mining' methods, known as 'in situ' recovery, are already in an advanced stage of development.

Research into schemes that would not only separate the oil from the sand, but also thin it for recovery by conventional methods, has been going on for many years. Virtually every major oil company holds leases in the tar sands and many are actively researching methods of developing their holdings.

At Cold Lake, Alberta's second largest deposit, Imperial Oil has established pilot plants to recover oil by steam injection (sometimes called "huff and puff").

Steam is heated to 600 deg. F., then pumped directly into the deposit at pressures up to 2,000 pounds per square inch. ("Huff") Not only does the heat thin the heavy oil, but the pressure later helps to pump the oil to the surface. Steam injection continues for about a month. Then for approximately three months the process is reversed; the injection well becomes a producing well as a mixture of warm oil, water and gas is pumped to the surface. ("puff") Once the amount of oil in the water reaches a low level, the steam injection cycle begins again. The operation is currently producing 5,000 barrels of heavy oil per day which is transported to a refinery in specially insulated trucks that keep the oil at 180 deg. F.

Of the projects now under review and pilot plants in operation Imperial Oil, which also happens to be one of the Syncrude owners, is well on the way to worthwhile fruition with its Cold Lake project, and only financing, coupled with certain other variable considerations, now seems to be the main issue outstanding.

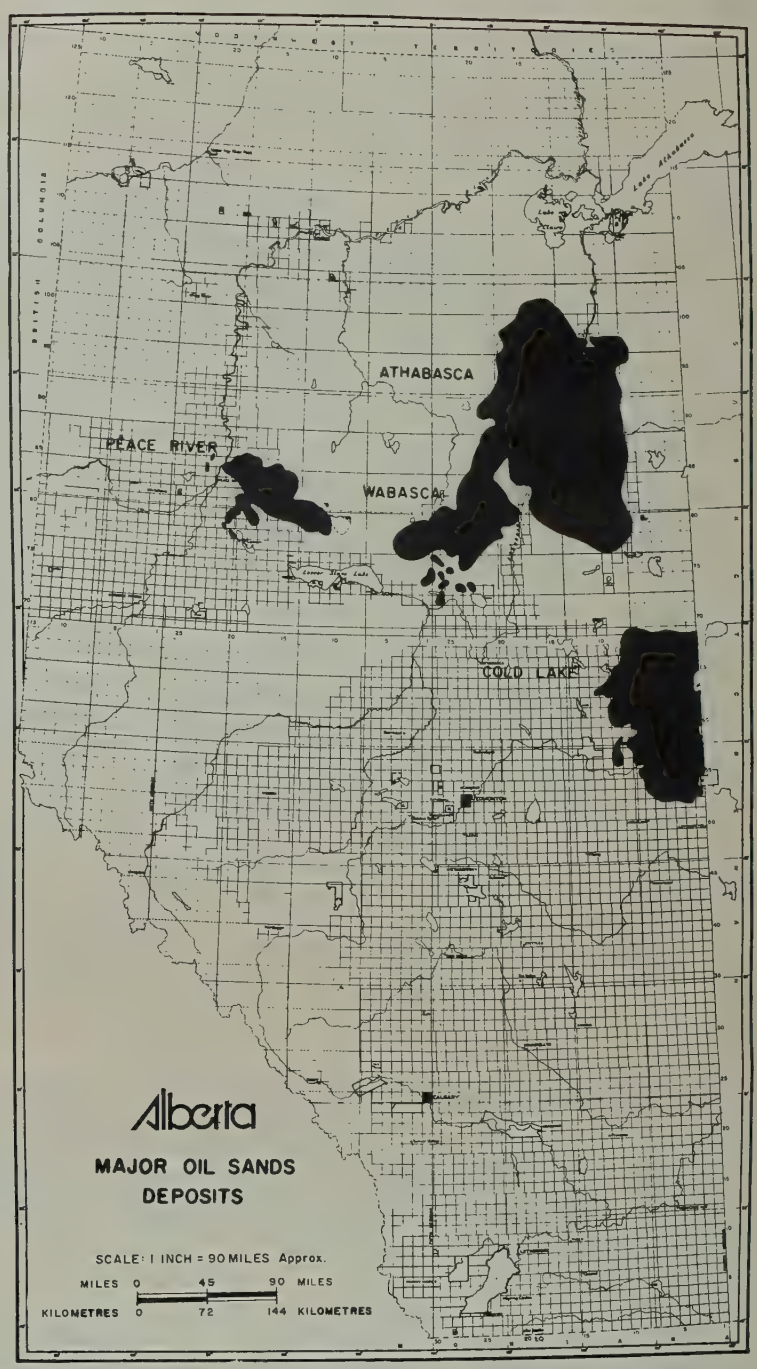
Shell Canada with a 3,500-barrels-per-day pilot plant in the Peace River deposit, has already spent $23 million in research since the 1950s and has completed four major tests, the last of which was the most successful, using steam to drive oil from the deposit.

Amoco Canada Petroleum has a new pilot plant on its Gregoire Lake property in the Athabasca Oil Sands, south of Fort McMurray. Amoco has completed a six-phase program on this property, at a cost of about $20 million.

Amoco and the Alberta Oil Sands Technology and Research Authority will have a pilot plant which will use underground combustion to produce oil from the deeply buried oil sand. Air will be injected to keep the formation burning and water will be used to help flush out the oil.

The pilot plant will be capable of producting about 2,000 barrels daily and should start operating this year.

The technologies proposed by BP Canada will combine underground combustion and steam injection to extract oil from the Cold Lake deposit by a project plant which will be capable of producing 500 to 1,000 barrels daily and will be located near previous BP pilot test sites, west of Imperial Oil's major Cold Lake pilot plant. The BP plant should be operating by mid-1978.

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# Oil-from-coal success story

## World technical lead established by South Africa

As a sidelight on energy resources, from South Africa comes a success story in the production of oil from coal.

Most of the pioneer work in this field was done by America, Germany and, to a lesser extent, by Britain. South Africa learned the know-how from these countries, but they neglected to follow through to perfect their techniques — they regarded the process as uneconomical and there were substantial natural oil resources available anyway — while South Africa persisted in its research, and during the last two or three decades it has built up a massive technical lead over the rest of the world.

These efforts culminated last year in the builing of a big new oil-from-coal plant — the second of a series — due to come on stream in 1981 with a capacity of two billion litres of petrol a year, together with other fuels, or some 40 per cent of the country's petrol requirements. A secondary benefit will be the large quantity of petro-chemical products and synthetic natural gas.

The yield is indicated at around 1.7 barrels per ton of coal.

The new plant, known as SASOL 2 (South African Coal, Oil and Gas Corporation) will be the three-times bigger sister of SASOL 1 — with 10 times the production capacity — which came on stream in 1955, producing eight liquid fuels and 40 by-products, including hydrocarbon oil, waxes, solvents, nitrogenous fertilizers and plastic raw materials.

In the processing one of the first steps involves the production of synthesis gas, which is a mixture of hydrogen and carbon monoxide in specific proportions. This is done by burning coal in pressure gasifiers in the presence of steam and oxygen under high pressure.

The hourly production of 180,000 cubic metres of pure synthesis gas requires more than 56,000 cubic metres of oxygen 570,000 pounds of steam and some 300 tons of coal.

During gas purification such products as sulphur, carbon dioxide, oil and benzole vapours, ammonia, cyanides and other impurities are removed by washing with methanol. Several other products emerge such as tar and oil which pass to tar distillation plants where road primer, creosotes and lighter naphtha fractions are separated.

*Refinery unit at Natref*

The naphthas are hydrogenated and distilled to produce benzoles for solvent use and for blending into petrol.

The effluent aqueous liquor from the gasification plant is then treated to remove tar acids by solvent extraction with butyl acetate. The liquor also yields ammonia which is combined with sulphuric acid to form ammonium sulphate — often used in the manufacture of fertiliser.

A portion of the gas emerging from the gas purification plant goes through a synthesis process: the combination of hydrogen and carbon monoxide with the aid of an iron catalyst.

The synthesis plant consists of five reactors operating in parallel where the mixture of products is separated in a recovery and refining plant to yield materials such as waxes, furnace and diesel oils, kerosines and petrol.

Gas conversion is not complete and the tail gas is utilized as feed by another synthesis plant or sold as fuel. In that latter instance this is sold as industrial gas which is piped to industries.

The tail gas, together with fresh gas from the purification plant, contains methane which must be converted into carbon monoxide and hydrogen. This is done by passing the gas through a reforming plant where the methane is reacted with steam and oxygen over a nickel catalyst at a temperature of about 1,000 degrees C.

After adjustment of the hydrogen-carbon monoxide ratio the gas is fed into three large reactors.

This process produces materials like butylenes, liquid petroleum gas, petrol and furnace oils, as well as substantial amounts of oxygenated products, including alcohols, ketones and organic acids.

Butylenes are converted to butadiene while styrene is made from ethylene extracted from the tail gas and benzene recovered from the coke ovens of South Africa's steel industry.


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# *When It's Happening We're There . . . . . .*

*.. at Calgary Power's Sundance Thermal Plant*

*.. at Syncrude Project*

*.. at Commonwealth Games Stadium*

*.. at Syncrude Project*

*.. at Calgary International Airport*

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# the northwest 55-DH

## Hydraulic Excavator

**"The one you've been waiting for"**

- 3—5½ cu. yd. rated capacity
- Reach 42'6"
- Over 125,000# working weight
- 27'8" maximum cut for 8' level bottom

Step up to the new 55-DH. You get Northwest's famous ruggedness and dependability. Massive bases, heavy duty attachments, a choice of dippers, and quality construction give you a superior excavator.

Joystick controls simplify operation. At your fingertips you control a function-matched system that has the power and precision to move more yards and set more pipe. A high torque swing system, 2-speed hoisting, and all independent functions combine to reduce cycle time and increase production. TWIN TORQUE™ Track Drive provides 2-speed travel, counter-rotation, and over 50% gradeability for tight quarter mobility.

The 55-DH has other benefits that can pay off on job after job. There's ease of transport with hydraulically lowered counterweight and retractable crawlers to 11'11". Sealed crawler rollers minimize lubrication time. And Northwest's Capsule Cab provides operator comfort to maximize his productive capabilities.

In toughest digging...the Northwest 55-DH can help you make it more profitable.

# Olsen Equipment Ltd.

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Edmonton, Alberta
TEL. 484-2211

5677 Burleigh Cres. S.E.
Calgary, Alberta
TEL. 252-9972

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# FACTS and FIGURES

## the Syncrude project

| | |
|---|---|
| • Site clearing commenced | December, 1973 |
| • Scheduled on-stream date | mid-1978 |
| • Construction to date | 75 per cent complete |
| • Size of total mine area | 2800 ha (7000 acres) |
| • Dimensions of mine | 4.3 km (14 000 ft.) long<br>7.6 km (25 000 ft.) wide<br>60 m (200 ft.) deep |
| • Size of plant area | 1100 ha (2800 acres) |
| • Tailings pond area | 3000 ha (7500 acres) |
| • Field Manhours to date | When project complete |
| • Synthetic crude project 26.2 million | 39 million |
| • Utilities plant 2.6 million | 4.0 million |
| • Vehicles on site | personnel vehicles including pick-up trucks - 375<br>Construction equipment (number of mobile units) 475 |
| • Storage Tank Capacity | 3 million bbls bitumen<br>778 000 bbls gas oil<br>256 900 bbls naptha |
| • Utility powerhouse | 260 megawatts installed capacity.<br>185 megawatts initial capacity.<br>(Installed capacity - sufficient to light city of London, Ontario.) |

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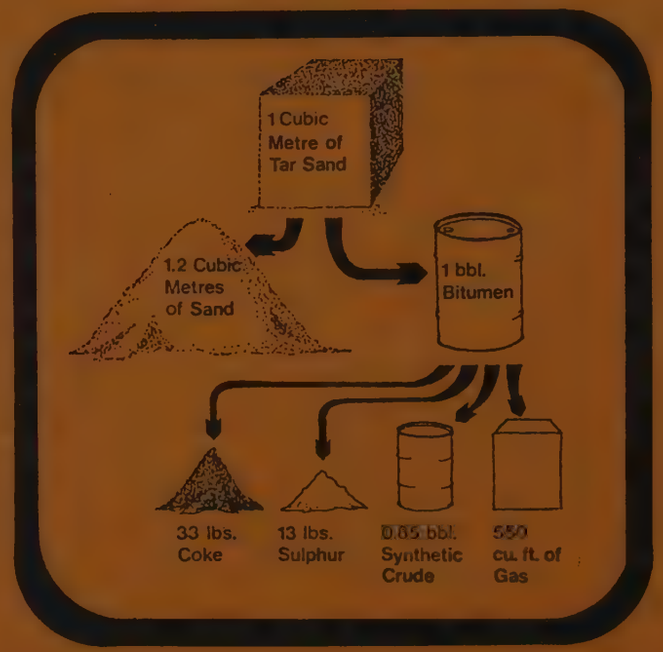
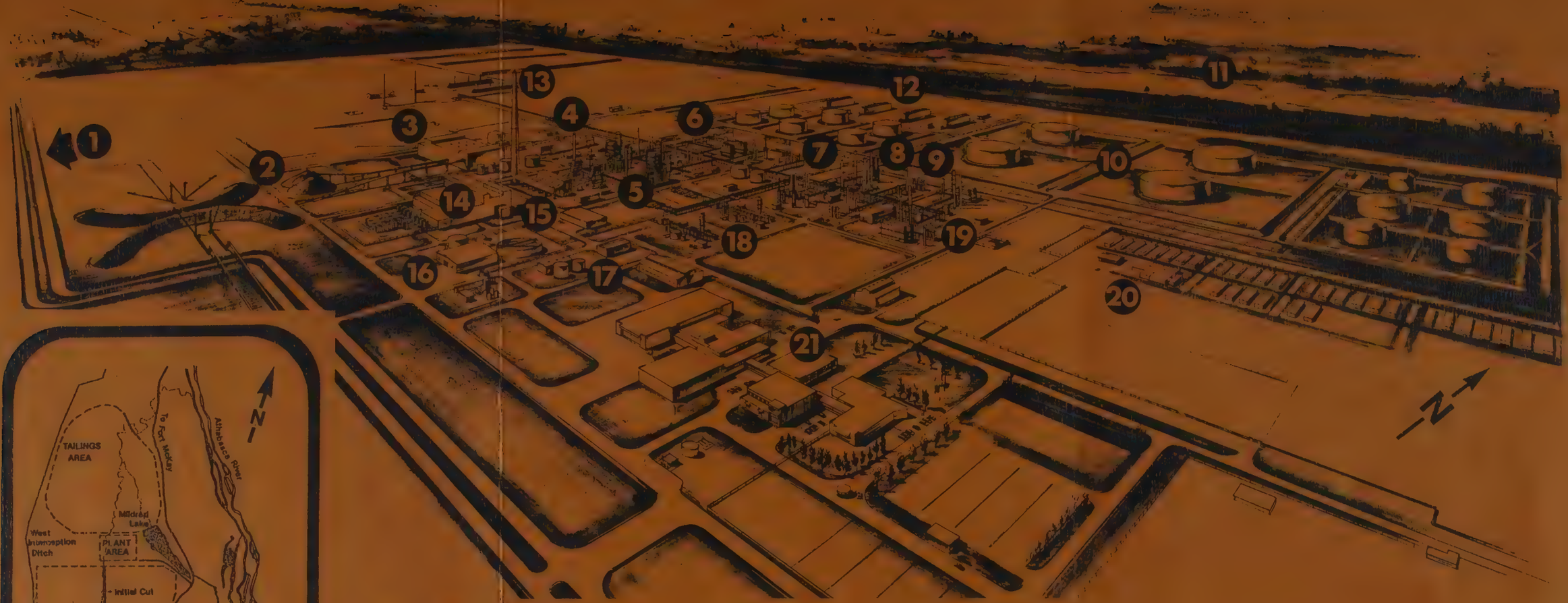
| | |
|---|---|
| • Water Treatment Plant | max flow 850 $dm^3/s$ (13 000 gals/min.)<br>demineralized water 450 $dm^3/s$ (6000 gals/min.)<br>cooling water 400 $dm^3/s$ (7000 gals/min.) |
| • Stack | 180 m (600 ft.) high<br>20 m (65 ft.) diameter base<br>8 m (26 ft.) diameter top |
| • Fluid Cokers | 63 m (210 ft.) high |
| • Draglines | 60 $m^3$ (80 cu. yd.) bucket<br>110 m (360 ft.) boom<br>104 m (340 ft.) working radius<br>6120 tonnes (6750 tons) over-all weight<br>9.6 megawatts (13 000 HP) power usage |


1 Cubic Metre of Tar Sand
1.2 Cubic Metres of Sand
1 bbl. Bitumen
33 lbs. Coke
13 lbs. Sulphur
0.05 bbl. Synthetic Crude
550 cu. ft. of Gas

| | |
|---|---|
| • Average Muskeg Depth | 3 m (10 ft.) |
| • Average Overburden | 15 m (50 ft.) |
| • Average Tar Sand Depth | 42 m (140 ft.) |
| • Total Workforce | 7200 |
| • Total Syncrude workforce on site | 100 - construction management<br>1100 - Operations Department |
| • Living accommodation for workers on site | 5500 |
| • Number of camp kitchens | 3 (North, South & West Camps) |
| • Seating capacity of 3 kitchens | 2800 |
| • Number of meal - time shifts | 3 half-hour shifts |
| • Recreational facilities for construction personnel include: | a gym, movie theatre, crafts rooms, billiards hall and a tavern called "The Muskeg Club" |
| • Total cost of project | $2 billion |
| • Committed expenditure to date (materials and labour) | 1.65 billion<br>(in Canada 80%)<br>(in Alberta 60%) |

JULY 1977



# the Syncrude project

1. Mine Area
2. Dump Pocket
3. Extraction Plant
4. Froth Treatment Plant
5. Fluid Cokers
6. Diluent Preparation
7. Water Heat and Sour Water
8. Gas Oil Hydrotreater
9. Naphtha Hydrotreater
10. Bitumen and Product Tanks
11. Tailings Area
12. Process and Utility Cooling Towers
13. Stack
14. Utility Plant
15. Precipitators and Control House
16. Water Treatment Plant
17. Firehouse
18. Amine Plants
19. Hydrogen Plant
20. North Construction Camp Area
21. Administration Buildings

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# Syncrude: a profile

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## HOW THE TAR SANDS BEGAN

The origin of the Athabasca Tar Sands is shrouded in mystery and controversy. Millions of years ago, much of northern Alberta was covered by a vast, shallow sea teeming with marine organisms; the Tar Sands cover a part of this ancient sea bottom. But where and how was the oil in the Tar Sands formed? And how did it come to be in its present location? Geologists cannot agree on an answer.

Explorer Peter Pond was the first white man to see the Tar Sands, as he ventured down the Athabasca River by canoe in 1778. Ten years later, Pond's successor, Alexander Mackenzie, took more serious interest in the unusual deposits of gooey petroleum he saw seeping from sandy outcroppings in the cliffs high above the river. He wrote in his journal:

*"The bitumen is in a fluid state, and when mixed with gum, or the resinous substance collected from the spruce fir, serves to gum the Indians' canoes. In its heated state it emits a smell like that of sea-coal . .*

In 1875, the first government geological study of the Tar Sands was carried out. Further surveys were initiated in 1882 and 1888. The Tar Sands' fame began to spread. In 1899 the chronicler of the Laird Expedition wrote:

*"That this region is stored with a substance of great economic value is beyond all doubt, and, when the hour of development comes, it will, I believe, prove to be one of the wonders of northern Canada."*

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Toward the end of the nineteenth century, the first entrepreneurs began to take an interest in the Tar Sands. Some of them were lured by the prospect of quick and easy riches.
But the entrepreneurs soon found that the Tar Sands' secrets were difficult and frustrating to unlock.

Syncrude

## SIXTY YEARS OF FRUSTRATION

One of the first Tar Sands developers was a German aristocrat, Count Alfred von Hammerstein, who was en route to the Klondike when he heard about the Tar Sands and decided to prospect for black gold instead. Von Hammerstein reasoned that if the Tar Sands contained so much petroleum in association with sand, there must be, somewhere in the Tar Sands, pools of more liquid petroleum that could be reached by conventional drilling.

He drilled a well at Poplar Island, six miles from McMurray, but went home a disappointed man.

Von Hammerstein was one of the first men to learn that the Tar Sands would not give up their secrets easily. He was not the last.

The search for liquid oil pools in the Tar Sands went on without success. In 1920, the Alberta Research Council began a long-term study to determine how bitumen (as the sticky oil was called) could be separated from the Tar Sands with hot water. As pioneered by an Alberta scientist, Dr. Karl Clark, this "hot water method" of separation became the focus of decades of research, and eventually became the basis of commercial production. But before that happened, entrepreneurs and scientists left the skeletons of abandoned pilot plants up and down the Athabasca River valley in their search for a commercially practical hot water design.

Interest in the Tar Sands fluctuated according to world energy supply and demand. The beginning of the Second World War brought a freshened interest in the potential of the region. The Alberta Research Council built a pilot plant at Bitumount capable of processing 500 tons of tar sand per day. But the discovery of the Leduc oil field south of Edmonton in 1947 temporarily quenched the enthusiasm of many Tar Sands developers; conventional oilfields in Alberta were closer to markets and production costs were cheaper.

Still, in dozens of laboratories and even basement workshops, scientists and inventors continued looking for better ways of extracting the bitumen from the Tar Sands. Some proposed spinning the tar sand in centrifuges; others proposed mixing it with cold water, attacking it with chemicals or bacteria, bombarding it with ultrasonic radiation, burning it underground, or melting it with an atomic blast. But in the end, serious commercial developers came back to the hot water method.

Time was on the Tar Sands' side. In the late 1950's there was an upsurge of research and development work by private industry; by the early 1960's, an energy-hungry world realized that conventional oil supplies were limited and the price of conventional crude oil was rising. Both factors made the Tar Sands more attractive. In 1967, Great Canadian Oil Sands Limited opened a commercial plant which now has an authorized production capacity of up to 65,000 barrels of synthetic crude oil a day.

Syncrude

In 1969, the Alberta government gave Syncrude approval to build a considerably larger project. In 1971, this project was granted permission to produce up to 125,000 barrels of synthetic crude oil a day.

## THE SYNCRUDE ORGANIZATION

Syncrude Canada Ltd. is the operator of a tar sands project funded by three petroleum companies — Canada-Cities Service Ltd., Gulf Oil Canada Ltd. and Imperial Oil Limited — and the Governments of Alberta, Canada and Ontario.

The project began with research and development work on Oil Sands Lease No. 17, about 25 miles north of Fort McMurray, in 1955. Between 1955 and the actual start of construction on the project in late 1973, some $60 million was spent on research and testing of tar sands technology, and preliminary engineering.

## TIMING AND MAGNITUDE OF THE SYNCRUDE PROJECT

Syncrude began construction of its project in late 1973 with operations to clear trees and muskeg from the site and drain the area. By the time the project is completed, the total construction and start-up cost of the plant itself is expected to reach some $2 billion, thus making this one of the largest single undertakings in recent Canadian history.

Syncrude

At the peak of construction in 1976 and 1977, the project will employ between 3,000 and 4,000 men and women. Operation of the project will require a permanent staff of more than 1,800 persons resident in Fort McMurray.

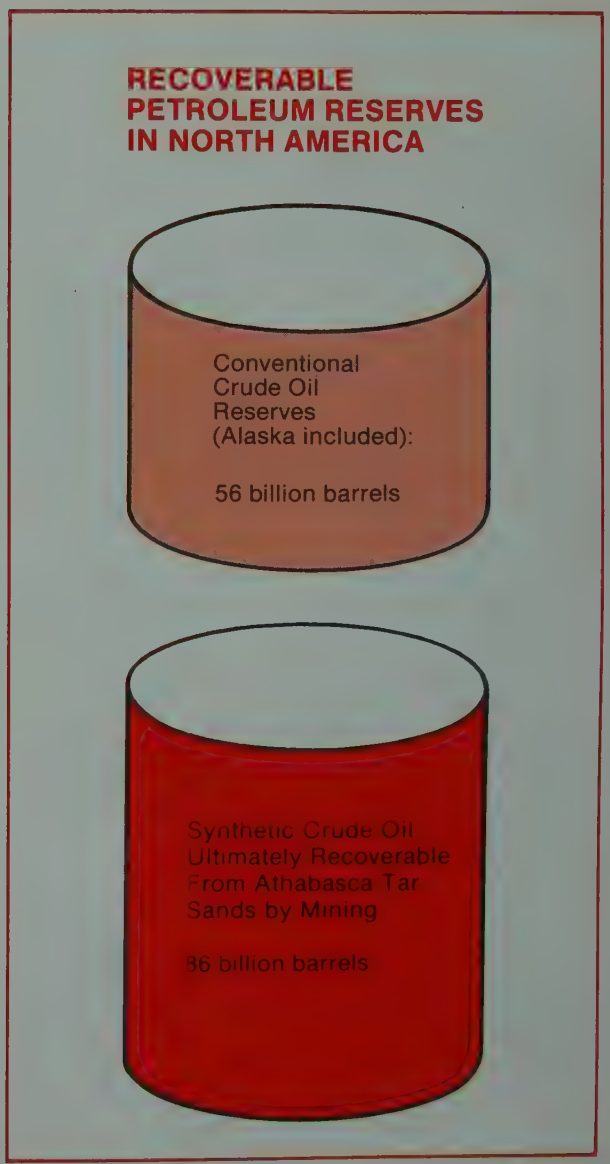
According to one study by a leading economist, the project will create over 11,000 permanent new jobs in the Canadian economy. As a result of the expansion brought about by the project, the population of Fort McMurray is expected to grow to some 25,000 by the time the plant begins operation in 1978.

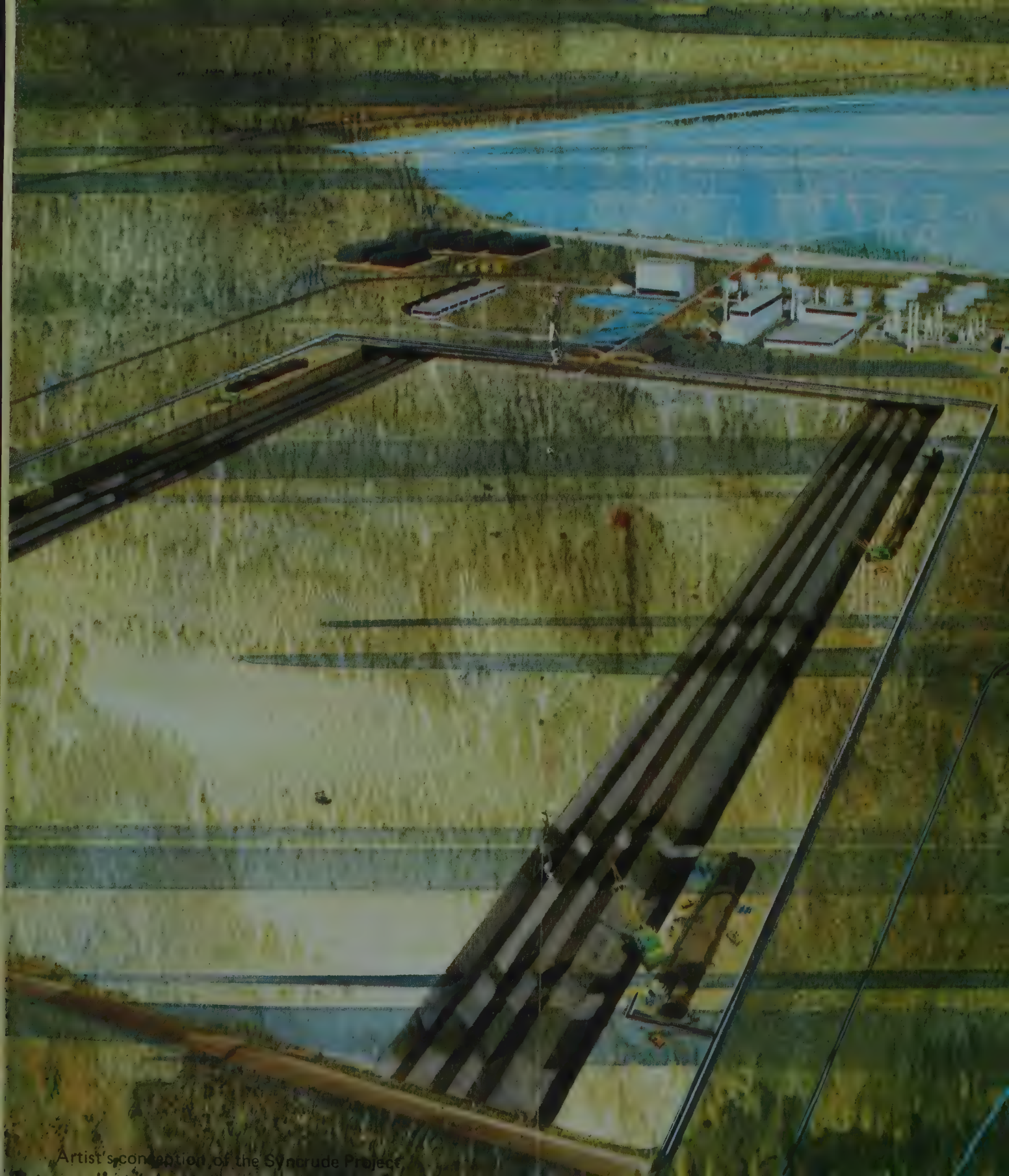
## THE TAR SANDS AND CANADA'S FUTURE

The Athabasca Tar Sands are one of the world's largest single energy sources. They contain approximately 600 billion barrels of oil in place.

About half of this oil is either currently recoverable or shows promise of being recoverable in the not too distant future. The part that seems destined for earliest large-scale development is the 110 billion barrels of bitumen sufficiently close to the surface to be eventually mined. These shallow tar sand deposits would produce sufficient bitumen to create 86 billion barrels of synthetic crude oil.

In other parts of the Tar Sand region, there are also some 200 billion barrels of high grade bitumen in deeper deposits which it may some day be possible to tap with "in situ" production techniques. Thus, the Tar Sands





Artist's conception of the Syncrude Project

The mi[illegible] operation, as seen [illegible]gh the artist's ey[illegible]

represent an ultimate potential of more than 300 billion barrels of bitumen. This compares with total proved North American reserves of 56 billion barrels of conventional crude oil.

The only comparable oil energy resources in North America are the oil shale deposits in the western United States. The oil shales may contain more than 600 billion barrels of petroleum, but no commercially proven method of producing this oil has yet been demonstrated.

The Tar Sands are also a storehouse of other minerals, including titanium, zirconium and vanadium. Some day, commercial development of this mineral potential may become feasible as well.

The Syncrude project will be the most advanced attempt to achieve large-scale commercial production of synthetic crude oil from the Tar Sands. All over the world, many people are watching the progress of the Syncrude project with intense interest.

## HOW WILL THE PROJECT OPERATE?

The key to success in tar sands mining is literally the ability to move mountains — every hour of the day, every day of the week, every week of the year. Present Syncrude plans are to use giant draglines and electrically-powered conveyors to mine 9,000 short tons of tar sand per scheduled hour and move it to a processing plant. Once at the plant, the tar sand will be treated with hot water and steam to separate the bitumen from the sand and

other solids. The clean sands will be hydraulically returned to the mining site and used in reclamation of the mined-out pit.

The bitumen will have its solids and water removed. Because bitumen in its raw state is impure and highly viscous, it will then be "cracked" and hydrogenated to remove undesirable components and improve its quality. The result will be high-grade synthetic crude oil to help meet Canada's projected needs.

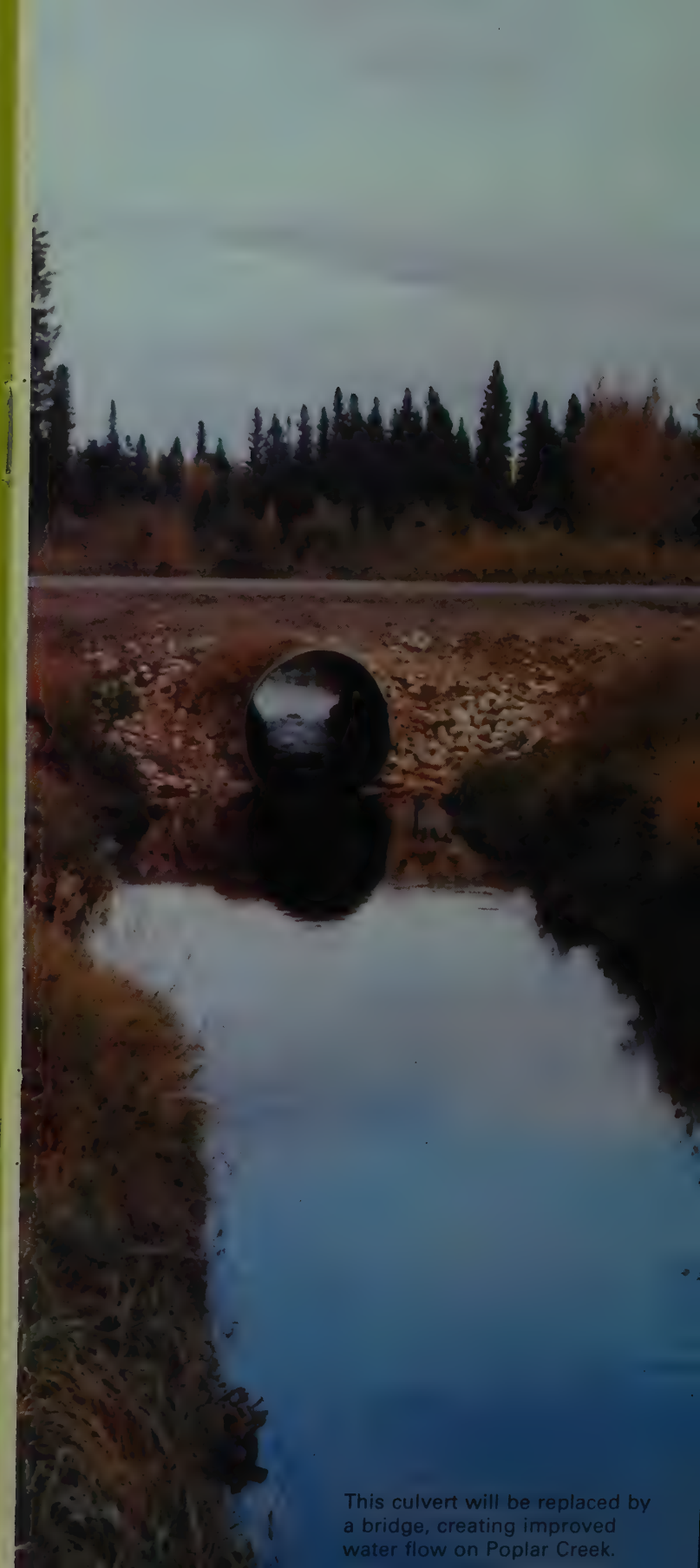
## PROTECTING THE NATURAL ENVIRONMENT

Syncrude intends to do everything it can to protect the wildlife, vegetation, appearance and air and water quality of the region, consistent with the commercial development of this natural resource.

Where environmental change is unavoidable, the company intends to contain and minimize this change and to reclaim affected areas to attractiveness and usefulness as soon as possible.

Syncrude conservation plans have been under development for some time. The company began this planning by commissioning its own detailed ecological studies well before construction began. A team of professional ecologists, biologists and environmental engineers is a vital part of the Syncrude organization.

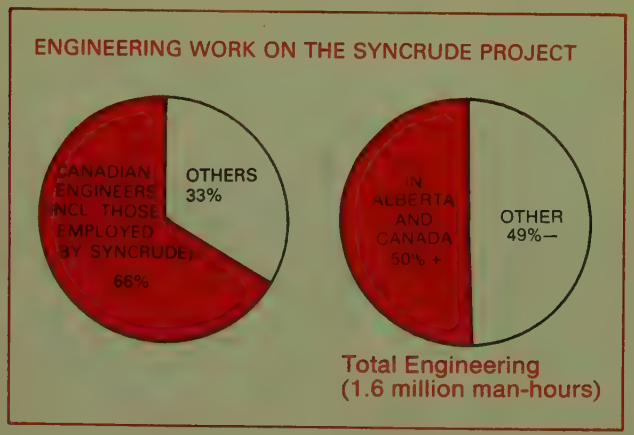
Although much of the site to be mined is swampy muskeg with little potential for recreation and timber production, Syncrude is developing plans for reclaiming and replanting all surface mining sites. One company objective is a reconstructed drainage system for the reclaimed areas, a system that will actually improve the present surface hydrology of the area.



This culvert will be replaced by a bridge, creating improved water flow on Poplar Creek.

## CANADIAN INVOLVEMENT IN THE SYNCRUDE PROJECT

Syncrude people want their project to make a positive contribution to life in Canada. More than 70 per cent of the goods and materials purchased for construction of the project are being purchased in Canada. Canadian engineers are responsible for approximately two-thirds of the total engineering work being done on the project, and Canadian-owned engineering subcontractors have been involved in the design of vital components of the project, thus helping to ensure that distinctive tar sands-type technology will remain in Canada. Canadian governments hold a substantial share of the company's ownership (30%) and, if they exercise all options, would be majority stockholders. Syncrude is energetically developing new programs to train and hire residents of north eastern Alberta for employment in the area.


ENGINEERING WORK ON THE SYNCRUDE PROJECT
CANADIAN ENGINEERS INCL THOSE EMPLOYED BY SYNCRUDE) 66%
OTHERS 33%
IN ALBERTA AND CANADA 50% +
OTHER 49%—
Total Engineering
(1.6 million man-hours)

Town of Fort McMurray

Syncrude project under construction.

## FURTHER INFORMATION

Do you have any questions about the Syncrude project? We would be happy to try and answer them. Please write or telephone:

Public Affairs Department
Syncrude Canada Ltd.
9915 - 108 Street
Petroleum Plaza
EDMONTON, Alberta T5K 2G8
(Area Code 403) 429-6161

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# Career Opportunities with Syncrude

Canada Ltd.

## Fort McMurray & Edmonton Alberta

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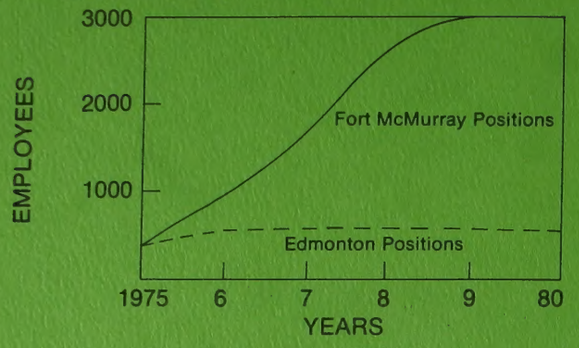
# Career Opportunities




Between 1976 and 1981 the Syncrude work force will grow from 600 to approximately 3,000 employees.

If you want a career with a progressive, young organization, and have the necessary training and experience, we encourage you to apply for employment. The listings below are designed to show where your particular training and experience may fit into the framework of positions available with Syncrude. While it does not detail every job that will be available, it should help you decide whether you wish to make an application for employment.

## Plant Operations Careers (Fort McMurray)

| LEVEL \ DEP'T. | MINING | EXTRACTION | HYDROCARBON PROCESSING | MAINTENANCE | ENGINEERING & CONSERVATION | UTILITIES | ADMINISTRAT. |
|---|---|---|---|---|---|---|---|
| MANAGEMENT & SUPERVISION | *EXPERIENCED MANAGERS WITH RELATED INDUSTRY BACKGROUND* | | | | | | |
| PROFESSIONAL | **ENGINEERS** — Mining, Civil, Geotechnical<br>**GEOLOGISTS**<br>**BIOLOGISTS**<br>**HYDROLOGISTS** | **ENGINEERS** — Mechanical, Chemical, Metallurgical | **ENGINEERS** — Mechanical, Chemical, Electrical | **ENGINEERS** — All Disciplines | **ENGINEERS** — All Disciplines | **ENGINEERS** — Electrical, Chemical, Mechanical | **SERVICES** — Accounting, Legal, Personnel, Computer/EDP. Public Rel., Medical, Purchasing, Gen. Admin. |
| TECHNICAL | **TECHNOLOGISTS** — Civil, Mining, Geological, Surveyors | **TECHNOLOGISTS** — Chemical, N.D.T. Inspection | **TECHNOLOGISTS** — Chemical, Petroleum, Laboratory | **TECHNOLOGISTS** — N.D.T. Inspection, Planners, Drafting | **TECHNOLOGISTS** Fire, Safety, Lab, General Eng. | **TECHNOLOGISTS** | **TECHNOLOGISTS** Medical, Computer/E.D.P., Buyers |
| TECHNICIANS — OPERATING — MAINTENANCE (Skilled & Semi Skilled) | **OPERATORS** — Dragline/ Bucket Wheel, Conveyors, Heavy Equipm't | **OPERATORS** — Process | **OPERATORS** — Process | **OPERATORS** — Equipment<br>**WAREHOUSE** | First Aid | **OPERATORS** — Power Eng. | Secretarial Clerical |
| | *MAINTENANCE SKILLS* (Mechanical — Electrical — Instrumentation — Metal) | | | | | | |
| TRAINEES | *NOT REQUIRED UNTIL 1977.*<br>• Grade 12 & some related experience required for most positions.<br>• Grade 10 or 11 minimum for some positions. | | | | | | |

# Corporate / Staff Department Careers (Edmonton)

A wide range of professional and skilled positions located in our Edmonton offices is listed below by department:

## RESEARCH:

- Research Chemists
- Research Engineers
- Laboratory Technologists

are continually adding to our knowledge of the chemical properties of the tar sands, its products and the extraction processes.

## PROJECTS:

- Field and Project Engineers
- Planners
- Cost Specialists
- Inspectors . . .

are engaged in monitoring and controlling project construction activities in both Edmonton and Fort McMurray.

## NORTHWARD DEVELOPMENTS LTD.:

This organization is responsible for housing and urban development to meet the needs of Syncrude employees in Fort McMurray. Their staff, includes construction and property management personnel, planners, estimators, and inspectors.

## FINANCIAL AND ADMINISTRATIVE SERVICES:

- Auditors
- Accountants
- Systems Specialists & Support personnel . . .

are required to design and maintain sophisticated programs and procedures.

## ENVIRONMENTAL AFFAIRS:

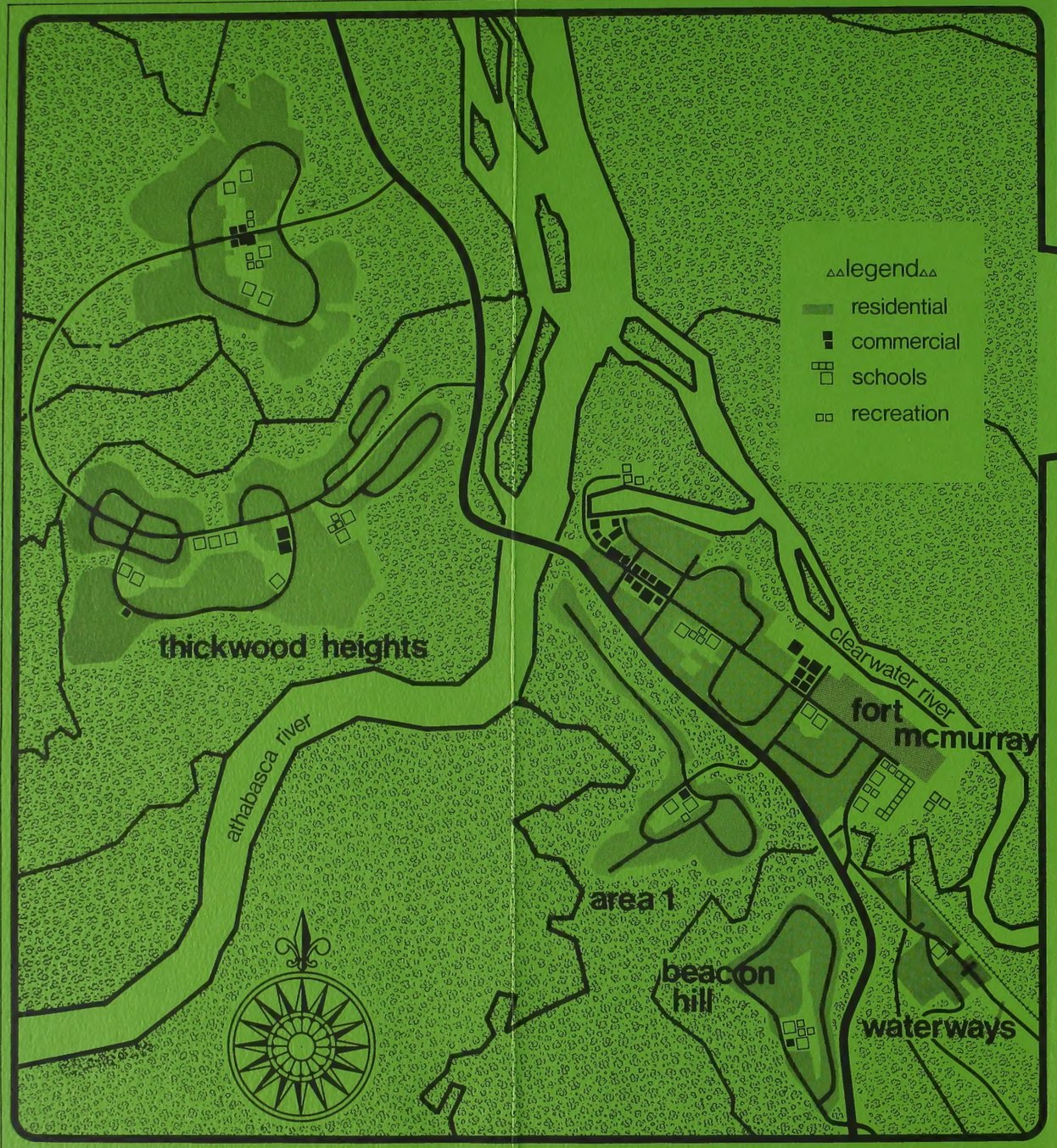
Environmental scientists with backgrounds in atmospheric, terrestrial, and aquatic environment are continuing to develop programs to minimize the impact of Syncrude's project on the environment, and to reclaim disturbed areas.

## ENGINEERING:

Our staff includes professionals and technologists from most engineering disciplines. Work is concentrated in the area of plant design and technical support services.

## EMPLOYEE RELATIONS:

The design and implementation of policies and programs involves specialists in recruitment, salary administration, benefits, organization and manpower development and industrial relations.



*Fort McMurray, showing surrounding subdivisions presently under development.*

# Fort McMurray

*The town of Fort McMurray*

Just 275 road miles northeast of Edmonton — Alberta's cosmopolitan capital city — the bustling town of Fort McMurray nestles in a sprawling, green river valley at the juncture of the Athabasca and Clearwater Rivers.

Centred in the heart of the oil-rich Athabasca Tar Sands, Fort McMurray has a unique personality. A blend of northern frontier town and sophisticated city, it is very much a family town, where freedom and individuality are highly valued.

Because of the tar sands development, McMurray is growing in leaps and bounds, resulting in almost complete urbanization. It is a fascinating microcosm of metropolitan centres across Canada because a majority of its residents have moved here from other cities.

From its earliest days as a campsite and trading post for explorers and fur traders, McMurray has grown to more than 15,000 people and estimates indicate that it will increase to 30,000 by 1978, when the Syncrude plant starts operation.

With close to 3,000 permanent jobs being offered by Syncrude the result is increased expansion of housing development, health care facilities, education, recreation, secondary industries and shopping complexes.

# Recreation

As a resident of Fort McMurray, you'll enjoy a variety of recreational activities. Nearby, there are excellent opportunities for fishing, hunting, camping, boating, snowmobiling and exploring. The town itself provides many entertainment and sporting facilities, including a modern indoor swimming pool, skating arenas and curling rink. Ski slope, tennis courts and golf course are easily accessible. Figure skating and badminton, boxing and basketball clubs are all active as are a number of service clubs. The Art Club, Open Stage Society and Overture Concert Society contribute to the cultural aspects of the community, while the younger residents enjoy organized baseball, hockey, soccer and other sports.

A motion picture theatre offers current feature films and modern hotels provide dining and lounge facilities. A $15 million cultural and recreational centre is in the planning stages.

You can watch television programs from the C.B.C. and CTV network stations in Edmonton, and a local cable system carries special features and community announcements. The local radio station, CJOK, is supplemented by CBX Radio in Edmonton. Local newspaper coverage is provided by Fort McMurray Today, a daily newspaper.

*Little league baseball, one of the organized sports activities.*

# Shopping

The community offers you all the retail services necessary for comfortable living: department, grocery, clothing and drug stores; furniture, appliances, hardware and sporting goods outlets; electrical, dry cleaning, plumbing and automotive services. Shopping facilities, in spite of planned developments and expansions, have not been able to keep pace with the rapid increase in population so some goods and services may periodically be in short supply. These are easily obtainable, however, with a weekend shopping trip to Edmonton, only five hours away by car.

# Education

If you have a family, education will be one of your major concerns. The quality of educational systems in Fort McMurray is on a par with the rest of Alberta, recognized as equal to any in Canada.

The Roman Catholic Separate School District operates the J. A. Turcotte School (Grades I to V) and St. John's School (Grades VI to IX).

The Public School District maintains the Dr. K. A. Clark Elementary School (Grades I to VI), the Clearwarer Elementary School and the Peter Pond High School (Grades VII to XII), which also accommodates students from the separate school system.

*A Fort McMurray elementary school classroom*

Four new elementary schools, each accommodating 525 students (one separate and one public in Beacon Hill and Thickwood Heights subdivisions) have recently opened and more new schools are being planned.

A new, combined, 750-student composite high school is under construction which will take students from both systems.

The new facilities provide an even greater range of specialized education which already includes options such as home economics, industrial arts, business education, typing, communication and drama.

Keyano College, the Alberta government institution, offers trade, technical and academic courses at introductory and advanced levels. Extension and evening courses range from automotive mechanics to wine-making, upholstery repair to cake-decorating.

A privately organized and operated school offers pre-kindergarten and early-grade level education for youngsters with mental, physical or social handicaps.

# Health Facilities

The Fort McMurray General Hospital has recently expanded to 56-beds and is now in the second phase of a program which is expected to increase its size to 150 beds, with attendant facilities, by 1980.

It presently has a complement of one surgeon, one obstetrician, and seven general practitioners; 30 registered nurses and 20 Certified Nursing Aides. The hospital is equipped with X-ray, laboratory and physiotherapy units and maintains a link with the cardiac institute in Edmonton. Minor surgery, up to appendectomies, can be performed locally. An air ambulance provides two hour service to Edmonton hospitals.

Hospital facilities are supplemented by a municipal nursing service which conducts pre-natal classes and child innoculation clinics. The community is also serviced by an optometrist, three dentists and a chiropractic clinic.

# Religion

Most denominations are represented in Fort McMurray. Churches in the community are All Saints Anglican, Fellowship Baptist, First United Pentecostal, Fort McMurray Gospel, Fort McMurray United, Trinity Lutheran and St. John the Baptist Roman Catholic. There are other active denominations which do not yet have their facilities, including Jehovah's Witnesses and The Church of Jesus Christ of Latter Day Saints.

# Transportation

Fort McMurray is about 275 miles north-east of Edmonton, just 45 minutes away by scheduled jet or five hours by car over an excellent paved highway. Pacific Western Airlines provides over 20 flights into Fort McMurray from the provincial capital every week and a second airline is seeking approval for additional service.

From Edmonton, you are only a quick jet flight away from such centres as Vancouver, Toronto, Chicago, Denver, Los Angeles, Las Vegas and San Francisco.

The project site is 25 miles north of the town of Fort McMurray. Transportation to and from the site will be provided by Syncrude.

# Climate

There's no denying the winters in Fort McMurray are cold but they are not as long nor as severe as you have probably imagined. When the temperature dips low, there is seldom any wind; the sun is often shining and the air is much dryer than in many southern areas so the cold isn't as penetrating.

In summer, the days are pleasantly warm, with comfortable, cool evenings. Although the frost-free period is comparatively brief, added hours of sunshine often result in extended, bright springs and long crisp autumn days.

In fact, the weather in Fort McMurray is not very different from that in Calgary or Edmonton.

# Income

Most major corporations offer "competitive" salaries. If you like the career opportunity Syncrude provides, you will find our starting salaries, and salary progression features, appealing.

*Syncrude Staff members are informed on project progress at regular information meetings.*

# Employee Benefits

Our program is designed to provide protection for our employee and his family. It also provides opportunities for financial growth.

In addition to basic conventional coverages, Syncrude's benefits are enriched by the following programs:

- Pension fully paid by Company
- Savings Plan
- Group Registered Retirement Savings
- Long Term Disability Insurance
- Higher Education Awards (For the children of Syncrude employees).
- Business Travel Insurance
- Survivors Income Benefits
- Group Home Owner and Auto Insurance
- Tuition Assistance

# Housing

As a Syncrude employee you will enjoy the benefits of the company's housing policy and program. The program is designed to provide modern, attractive, comfortable accommodation in a variety of types, sizes and price ranges. Single family homes, apartments and town-houses are being developed in new subdivisions by Northward Developments Ltd., a Syncrude subsidiary. To moderate the cost of your housing Syncrude provides rental and purchase assistance.

*Syncrude housing under construction*

*A Syncrude family at home*

# Relocation Costs

Syncrude's relocation policy is generous and designed to substantially defray the costs incurred by a new employee, and his/her family relocating to join Syncrude.

# Alberta — Tax Advantages

People living and working in Alberta enjoy higher take home pay and have more discretionary income for two reasons:

- Alberta has the lowest Provincial Income Tax rates in Canada.
- No Provincial Sales Tax.

*The Syncrude Project under construction.*

If you are interested in a Syncrude career and feel you qualify, please send a detailed description of your education, work experience, and salary history to:

Syncrude Canada Limited
P.O. Box 4020
Fort McMurray, Alberta
Canada

The information will be treated in strict confidence and we will advise you on the status of your application.

**Syncrude**

**we want you in on what we're doing**